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FARM MACHINERY AND EQUIPMENT

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BY

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SECOND EDITION
SEVENTH IMPRESSION

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PREFACE TO THE SECOND EDITION

Many developments have occurred in the field of farm machinery in the seven-year interval between the first and second editions of this book. Improvements in tractor implements, especially attachments for row-crop tractors, have brought about changes in farming practices that have been largely instrumental in reducing labor requirements and production costs.

The rapid progress in the mechanization of agriculture has made it necessary in the preparation of this edition to revise and rewrite the greater portion of the text. Much obsolete material has been discarded and replaced with new subject matter. New chapters have been added, discussing farm machinery in its relation to agriculture, dusting and spraying equipment and terracing machinery. The chapters on wagons and motor trucks have been combined and supplemented with a treatment of the automobile trailer. Many of the illustrations have been replaced, by either new or improved ones to show the latest types of machines now available.

The discussion of the developments on the mechanical harvesting of cotton has been brought up to date, giving results of experimental work done during the past few years. Improvements in haying machinery, such as placing the gears in a bath of oil enclosed in a dustproof case and the windrow pick-up baler, are described and illustrated. A number of illustrations show machinery equipped with rubber tires, an innovation on many farm implements. In general, an effort has been made to bring the entire subject matter of the text up to date and to show the latest developments in the field of farm machinery.

The author is indebted to many farm implement manufacturers for their splendid cooperation in furnishing descriptive literature and illustrations. He especially desires to express his appreciation to Professors F. R. Jones and Donald Christy for their helpful suggestions and criticisms. A sincere attempt was made to give credit wherever due, and any oversights were not intentional.

H. P. SMITH.

COLLEGE STATION, TEXAS,
February, 1937.

PREFACE TO THE FIRST EDITION

This book is intended primarily as a text for use in farm machine classes for agricultural and agricultural engineering students. It is also intended as an aid to farm equipment salesmen and dealers, agricultural extension workers, farmers, and others interested in the introduction and use of labor-saving equipment for the farm.

It has been the aim of the author to present a treatise on farm machinery covering the most important types of machines used in general farming. The book opens with a discussion of the more important phases of physics which are of assistance in analyzing the design, operation, and adjustment of the machines taken up in later chapters. Following this is a brief description of the various elements of a farm machine together with typical applications. An innovation is the chapter on the selection of farm machinery in which are given suggestions as to the best place to purchase the equipment.

The main part of the book is a discussion of the various types of farm machines, their design, construction, operation, and efficiency. More space is given to plows than ordinarily because of their importance in the preparation of the seed bed for all crops. Machinery used in the growing, harvesting, and preparation of cotton for the market is given special attention. The combined harvester-thresher is thoroughly covered. The author has endeavored to arrange the discussion of the machines in the logical sequence in which they are usually applied to farm work.

The entire field of farm machinery as applicable to this country has been covered as fully as space will permit.

An effort was made to cover the latest types of machines developed for the farm; those machines that have proved to be economical in their use and instrumental in reducing the cost of production.

The author is indebted to: Dr. O. W. Silvey, of the Physics Department, and Professor E. R. Alexander, of the Department of Agricultural Education, of the Agricultural and Mechanical College of Texas. Thanks are also due Miss Daisy Brogdon for her assistance in preparing the manuscript.

H. P. SMITH

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS,
COLLEGE STATION, TEXAS.
May, 1929.

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PART I

IMPORTANCE OF FARM MACHINERY TO AGRICULTURE

CHAPTER I

FARM MACHINERY AND ITS RELATION TO AGRICULTURE

In the beginning all crops for the sustenance of mankind were produced and prepared by human muscles. Many centuries passed before the power of animal muscles was used to relieve those of the human being. With the discovery of iron, tools were fashioned that further relieved the labor of human muscles. The transition from subsistence farming to this modern power-farming age was at first slow, but with the development of the steel plow, the internal-combustion engine, and other modern farm machines, the movement has accelerated beyond the wildest dreams of our forefathers. The changes brought about during the past decade have so tremendously affected human values that one wonders what effect farm machines of the future will have on our welfare.

1. Machinery Reduces Hours of Labor.—The effect of the mechanization of agriculture is shown in the number of man-hours required to grow and harvest an acre of wheat yielding 20 bushels. In 1830, when the grain was sown by hand and harvested by hand with a cradle, 55.7 man-hours were required. In 1896 with the use of the horse-drawn drill and binder, it took 8.8 man-hours; while in 1930 with the tractor-drawn drills and combine, it required only 3.3 man-hours.¹ The use of rubber-tired equipment will, no doubt, further reduce the requirements. Similar reductions in man-hour requirements have been made in the production of most field crops. Cotton, as a whole, requires more man-hours in its production than any of the major crops grown. The average number of man-hours required to grow 1 acre of cotton in the High Plains region of Texas is 10.25 with one-row horse-drawn equipment, 6.4 man-hours with two-row, horse-drawn equipment, 5.15 man-hours with two-row tractor outfits, and 4 man-hours with four-row tractor machines. An average of 14.2 man-hours per acre are required to harvest an acre of cotton.² Farmers in central Iowa usually expend from 6 to 12 man-hours of labor

¹ U. S. Dept. Agr., *Misc. Rept.* 157, p. 2, 1933.

² Texas Agr. Expt. Sta., unpublished data, 1936.

per acre in seed bed preparation, planting, and cultivating corn. With certain combinations of equipment and methods at Iowa State College, however, the requirements were only from 3 to 5 man-hours per acre.

2. Good Equipment Reduces Production Costs.—Much has been accomplished through the use of modern farm machines in reducing cost of producing farm crops. It is not hard to visualize the difference in the cost of producing an acre of wheat in 1830 as compared to that of 1930. Studies made in the High Plains region of Texas on the production of cotton show the influence of types of farm machines on production costs.¹ To grow and harvest a pound of cotton, where the average yield was 180 pounds per acre, cost 9.2 cents with one-row, and 8.86 cents with two-row horse-drawn equipment, and 7.59 cents with two-row, and 6.77 cents with four-row tractor equipment. Interest and rent are included in these costs.

Production costs are also influenced by soil type, topography, climate, kind of crop, and the size and contour of the field.

3. Special Machines for Special Crops.—The nature of plant growth is such that only a few farm machines are adapted to more than one crop. Planters for planting row crops by minor changes will sow the seeds of most field row crops. Grain drills will plant the seeds of all the small grains, but special attachments are needed for the small grass seeds. Row-crop cultivators are suitable for all crops grown in rows spaced from 36 to 42 inches apart. Broadcast binders, combines, and threshers can be adjusted to satisfactorily handle any of the broadcast crops and some of the row crops. Some of the one-crop machines are the corn picker, potato planter and digger, beet digger, cotton harvester, and cotton gin. Plows and harrows are indispensable in the preparation of the seed bed for all row and broadcast crops.

4. Rubber Tires on Farm Machines.—Numerous tests with tractors and other farm machines equipped with rubber tires reveal the relative advantages and disadvantages.

Advantages of rubber-tired tractors are: (1) higher operating speeds, (2) less power required for same load, (3) less fuel consumption, (4) decreased rolling resistance, (5) less vibration, (6) easier handling qualities, and (7) greater comfort for the operator.²

Disadvantages are: (1) difficulty of holding on listed ground, (2) greater slippage on wet soil, (3) greater initial cost, (4) possibility of punctures.

When used on other farm machines, such as combines, potato planters and diggers, and sprayers, rubber tires reduce the drawbar pull, fuel

¹ Texas Agr. Expt. Sta., unpublished data, 1936.

² *Agr. Eng.*, Vol. 14, No. 2, p. 39, 1933; Vol. 16, No. 2, p. 45, 1935; Vol. 17, No. 2, p. 73, 1936.

consumed by the tractor, vibration and dust, and make transportation easier from field to field and along highways.

Adaptation of rubber tires to all types of farm machines is retarded primarily by the expense of making the change.

5. Machinery for Terraced Fields.—The expansion of soil and water conservation on farms has created a need for specially designed farm machines that will operate efficiently on terraced fields. Manufacturers have engineers studying the problems and, no doubt, will in the near future produce plows, planters, cultivators, and harvesters that will be flexible enough to operate satisfactorily on terraced and contoured lands.

6. Breeding Crops to Suit Machinery.—Certain field crops do not readily lend themselves to machine harvesting. Varieties of grain sorghum have drooping heads that make it difficult to head them without cutting excessively long stems. Plant breeders have developed varieties of sorghum that have straight and erect heads. Corn cannot be combined in the North because it does not dry rapidly and shell easily. It could be combined in the South where it matures early. Cotton does not mature its fruit uniformly and produces long vegetative and fruiting branches with an abundance of foliage, thus making it difficult to harvest with machinery. Plant breeders have made considerable progress in developing a type of cotton plant that is more suitable to machine harvesting.¹

7. Farm Management.—Farm machines designed for higher speeds, constructed of heat-treated steels, and equipped with more durable bearings will lessen operating time and lower costs. Terracing and contouring of fields will cause changes in farming practices, both in types of machinery used and in cropping systems. In the past, machines were designed for large farms, but now the trend is to develop machinery for the small farms. These and various other factors will materially affect the management of farm labor and equipment.

8. The Future.—Improvements in farm machinery during the past decade continue so rapidly that one wonders what the future holds. Rather than forecast for the future several questions are enumerated:

1. Will a new steel for moldboard plows, that recently scoured well during tests made in Texas, make the disk plow obsolete?
2. Will the rotary tillage type of plow be extensively used?
3. Will a large percentage of the cotton crop be harvested mechanically in the near future?
4. Will a new type of stalk cutter be developed to cut standing cotton, corn, and sorghum stalks into short sections that can be readily covered and that will not interfere with the planting and cultivating of the next crop?
5. Will a sorghum header be developed that will cut the stems of uniform length below the heads? Will this lead to the development of a grain-sorghum combine?

¹ *Texas Agr. Expt. Sta. Bull.* 452, p. 54, 1932 and 511, p. 32, 1935.

6. Will the plows, planters, cultivators, and harvesters of the future be equipped with rubber tires and antifriction bearings?
7. Will beets be pulled and topped automatically with machinery?
8. Will the auto trailer displace the old-time farm wagon?
9. Will the farm machine of the future be provided with accessories designed for comfort of the operator?

Numerous other questions may be cited but these are sufficient to show the possibility for improving farm machinery in the future.

PART II

PRINCIPLES OF FARM MACHINERY

CHAPTER II

MECHANICS

A clear conception of the fundamental principles of mechanics, as well as their practical application to machinery, is necessary to a comprehensive study of farm machinery.

9. Force.—Force is the action of one body upon another which tends to produce or destroy motion in the body acted upon. Force may vary in magnitude and in method of application. In general, force is associated with muscular exertion. This, however, does not completely cover the scope and work of force because an electrical current, freezing of a liquid, and ignition of explosives may exert a certain amount of force. To be able to compare different forces, there must be some unit by which to compare them. Such a unit is called the *pound weight*.

10. Work.—Whenever a force is exerted to the extent that motion is produced, work is performed. Work is measured by the product of the force times the distance moved. There is a distinction between the term *work* in common use, and the term *work* used scientifically. The latter is referred to above. By this it can be seen that a man could have worked very hard and become fatigued but not have accomplished any work in a scientific sense. For example, suppose a man pushes on a door or gate all day and fails to open it; physically he has worked and is tired out, but scientifically he has not accomplished any work because he did not open the door; the force applied did not move the door any distance. *The unit used in measuring work is the foot-pound*, force being measured in pounds and distance in feet. A foot-pound of work is done when a body is moved 1 foot against a force of 1 pound weight. The amount of work required to place a 100-pound bag of grain on a wagon which has a box 4 feet from the ground can be determined by multiplying the weight, 100 pounds, by the height, 4 feet, which will equal 400 foot-pounds of work done to place the bag of grain upon the wagon.

11. Power.—Power is the rate of doing work. To determine the power used or transmitted by a machine, the force must be measured,

also the distance through which the force acts, and the length of time required for the force to act through this distance. The units of power ordinarily used in America are the foot-pound per second, the foot-pound per minute, and the horsepower.

If a body is moved 1 foot per second against a force of 1 pound weight, the rate of work is 1 foot-pound per second. If it moves 1 foot per minute against the same force the rate is 1 foot-pound per minute. If it moves so that 33,000 foot-pounds are done each minute, the rate is 1 horsepower. The horsepower is based on the rate that a 1,500-pound horse can do work. If such a horse pulls 150 pounds, 10 per cent of its weight, and moves at the rate of 220 feet per minute, or $2\frac{1}{2}$ miles per hour, it would do 33,000 foot-pounds of work per minute, this being equal to 150 times 220 or 33,000 foot-pounds, or 1 horsepower.

12. Simple Machines.—A machine is a device that gives a mechanical advantage which facilitates the doing of work. It is usually associated with such tools as grain binders, threshing machines, mowing machines, and other machines. But really such machines are made up of many simple machines.

There are six simple machines; namely, the lever, the wheel and axle, the pulley, the inclined plane, the wedge, and the screw. These can be reduced to three, which are the lever, the inclined plane, and the pulley. Any simple machine is capable of transmitting work done upon it to some other body. The mechanical advantage of a machine is the ratio of the force delivered by the machine to the force applied. The force which operates the machine is called the *applied* force. The efficiency of the machine is the ratio of the work accomplished by the machine to the work applied to the machine. If the efficiency of a machine could be 100 per cent, perpetual motion would exist. Since there is always a loss due to friction, the efficiency of the machine falls below 100 per cent.

13. The Lever.—The lever is a rigid bar, straight or curved, which rotates about a fixed point called the *fulcrum*. It has an applied force and a resisting force that are well defined by their names. The lever arms for a straight bar are the parts or ends on each side of the fulcrum if the forces act perpendicular to the bar. The mechanical advantage of the lever is the ratio of the length of the lever arm of the applied force to the length of the arm of the resistance force, or

$$\text{Weight} \times \text{weight arm} = \text{applied force} \times \text{force arm.}$$

Levers are of three classes (Fig. 1). In the lever of the first class the applied force is at one end and the resisting force or force exerted by the object to be moved at the other. The fulcrum, or fixed point, is placed between the applied and the resisting forces. Such a lever may

have a mechanical advantage of any value, depending directly upon the length of the lever arm between the fulcrum and the point of applied forces as compared with the length of the lever arm between the fulcrum and the point of resisting force. The majority of levers found on farm machinery will fall in this class.

Levers of the second class have the applied force at one end, the fulcrum at the other, and the resisting force between them. This class of levers will have a mechanical advantage that will always be greater than unity. As in the case of the lever of the first class, a lever of the second class also sacrifices speed and distance for a gain in pull or force.

A lever of the third class has the resisting force at one end, the fulcrum at the other, and the applied force between them. The mechanical

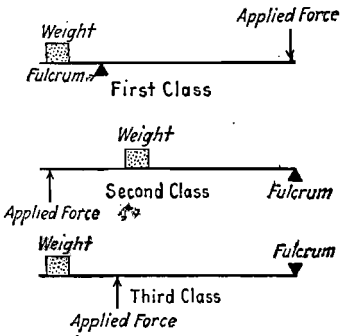


FIG. 1.—The three classes of levers.

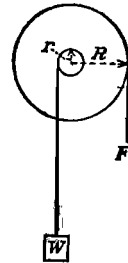


FIG. 2.—Wheel and axle.

advantage of this kind of lever is always less than unity, and, unlike the two previous classes, work is sacrificed for a gain in speed and distance. An ordinary crane is a lever of this kind.

14. The Wheel and Axle.—(Fig. 2.) This is a modification of the lever, and acts on the same principle, only the forces operate constantly. The center of the axle corresponds to the fulcrum, the radius of the axle to the short arm, and the radius of the wheel to the long arm. The mechanical advantage is expressed by the equation:

$$F \times R = W \times r.$$

where W = weight.

F = force applied.

R = radius of wheel.

r = radius of axle.

15. The Pulley.—A pulley consists of a grooved wheel turning freely in a frame called a block and is a lever of the first or second class. There are several different applications of pulleys depending on their arrangement. A single fixed pulley affords no mechanical advantage except to change the direction of motion. When one or more fixed pulleys and one or

more movable pulleys (Fig. 3) are used in combination, they form the block and tackle. The mechanical advantage varies directly as the number of ropes that support the movable pulley and the weight,

$$w \times h = F \times 3h.$$

or

$$\frac{w}{F} = 3 \text{ theoretical mechanical advantage}$$

where w = weight.

h = distance weight moves.

F = force applied.

3 = number of ropes supporting w .

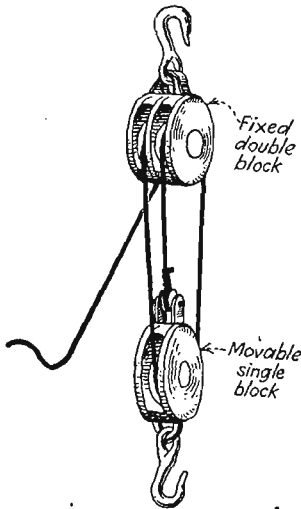


FIG. 3.—Block and tackle.

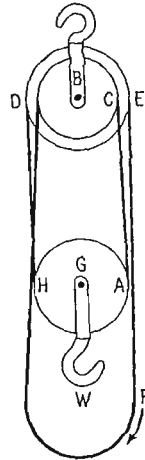


FIG. 4.—
Differential
hoist.

The differential pulley (Fig. 4) is a modification of a block and tackle but differs in that the two pulleys D and C are of different radii and rotate as one piece about a fixed axis B . The endless chain passes under and supports the movable pulley G and any weight attached to it. To raise a load, force is applied downward to chain F , which will rotate pulleys C , D , and G , causing the chain to wind up on the larger fixed pulley D and unwind on the smaller fixed pulley C , thus raising movable pulley G . In operation consider that point D of the section of chain DH moves up through an arc whose length is equal to BD . At the same time the point C of the section of chain CA will move downward an arc, a distance equal to BC . The length of the chain loop $DHAC$ will be shortened to

$BD - BC$, which will cause pulley G to be raised half this amount. P , the pulley force, is then applied to the section of chain EF and the weight W is lifted at G . The mechanical advantage will be:

$$P \times BD = W \times \frac{1}{2}(BD - BC).$$

16. The Inclined Plane.—The inclined plane, shown in Fig. 6, is an even surface sloping at any angle between the horizontal and the vertical.

The law or principle which governs the *inclined plane* in mechanics is that the force applied is increased as many times as the length of the inclined plane is greater than the elevation H . Briefly, it is equal to the length over the height, varying

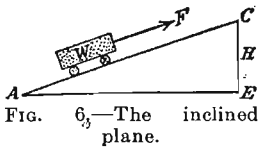


FIG. 6.—The inclined plane.

with the direction in which the force is applied. Instead of lifting the entire weight of the object vertically, part is supported on the plane and part by the force. Referring to Fig. 6, if F causes the weight W to move from A to C and parallel to the plane, the work done is F times AC , while the work done against gravity is the weight W times CE if friction is disregarded, or briefly,

$$F \times AC = W \times CE.$$

If the force is parallel to the base AE , the advantage would be

$$F \times AE = W \times CE.$$

17. The Screw.—The screw (Fig. 7) is the application or modification of the inclined plane combined with that of the lever. The threads winding around a cylinder bear the same relation to the inclined plane that a winding staircase bears to a straight one. When the screw is turned on its axis with the aid of a lever or gear, its sloping thread causes the load to move slowly in the direction of its vertical axis. The vertical distance between threads is called the *pitch* of the screw.

The mechanical advantage is figured upon the condition that the

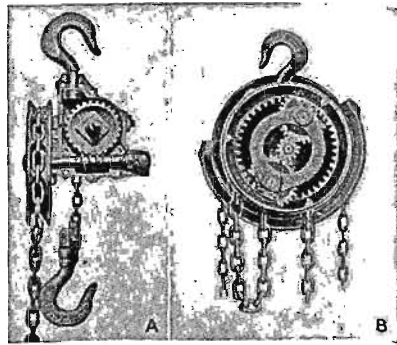


FIG. 5.—Geared differential hoists. A, worm-gear hoist; B, planetary-gear hoist.

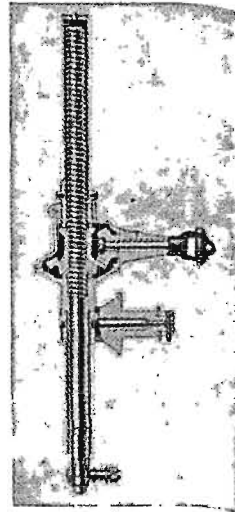


FIG. 7.—Screw operated by miter gears.

applied force moves through a distance equal to the circumference of a circle whose radius is the length of the jackscrew bar or the radius of the driving gear, while the weight is being moved through a distance equal to the pitch of the screw.



FIG. 8.—
Wedge.

18. The Wedge.—The wedge is a modification of the inclined plane. Really it consists of two inclined planes placed base to base (Fig. 8). The force pushing on the wedge into any material, such as a log, will cause forces to act perpendicular to each of the two faces of the wedge.

CHAPTER III

FRICTION AND ITS REMEDY

The chief cause for machinery wearing out can probably be attributed to improper and insufficient lubrication. Much of this can be traced to the poor construction of bearings and the failure to provide adequate means of conducting the lubricant to the bearing units. The whole need for lubrication is due to friction.

19. Friction.—Friction is helpful in clutches and to prevent slippage of belts on pulleys. It is that force which acts between two bodies at their surface of contact so as to resist the sliding of one body on another. When any object is being dragged along upon any other object, friction between the two tends to stop the one that is being dragged. When one surface rests upon another, there is a tendency for the inequalities of the one to fit into those of the other producing an interlocking not unlike that produced by putting the cutting edges of two saws together. If such interlocking has occurred, it is only possible to move one body over that of the other by separating them or by tearing off the interlocking surfaces. No matter how smooth the surfaces may be, there are still some elevations and depressions remaining which will permit a small degree of interlocking.

20. Rolling Friction.—When one body rolls upon another, the friction is very much less than where one body is sliding upon another. The resistance in this case is called the *rolling resistance* or *friction*. This can readily be demonstrated by attempting to carry as much upon a sled which has no wheels as upon a wagon or any other vehicle which is mounted on wheels. Many of the farm implements are now using some type of antifriction bearing in the form of balls or rollers to diminish the amount of friction. The use of such bearings reduces friction and the efficiency of the machine is materially increased. Friction in moving parts of machinery causes wasted energy and it is, therefore, desirable to reduce it to the smallest possible amount.

21. Lubrication as a Remedy for Friction.—Lubrication tends to reduce friction. The theory of the action of lubrication is that a thin film of the lubricant adheres to the bearing and another to the shaft and completely separates the metal surfaces. Then, these films slip one on the other reducing the amount of friction. This is because the friction of lubricants is much less than that between the metal parts. A lubricant may act in different ways in reducing the amount of friction: first, by causing

the greater part of the resistance to be due to the slipping of oil over oil; second, that a lubricant fills up the small depressions in the two frictional surfaces and in this way prevents the so-called *interlocking*.

22. Forms of Lubricants.—Lubricants are available in three forms: *fluid oils, semisolid, and solid*. *Fluid oils are those that flow freely, such as, gas engine cylinder oils and oils used for lubricating various bearings by means of oil holes or oil cups*. Semisolids include the soft greases, transmission, and differential grease. Solid lubricants consist of graphite and mica. Of these forms, soft greases and oils are most generally used to lubricate farm implements.

23. Kinds and Sources of Lubricants.—All lubricants have three general sources: animal, vegetable, and mineral. Animal oils are lard, tallow, and fish oils. Vegetable oils are cotton-seed oil, castor oil, olive oil, and linseed oil. Mineral oils are oils obtained by refining crude petroleum. Of all these, mineral oils are the most universally used on the farm, because they can withstand higher temperatures without breaking down.

24. Use of Lubricants.—Gill¹ says: "The cardinal principle underlying all lubrication is to use the thinnest (or least viscous) oil that will stay in place and do the work." It naturally follows that a thin or light oil should be used for light work and as the load increases the lubricant should be heavier. Where the speed of the sliding surfaces is relatively high, and the pressure of the bearing is not a heavy one, thin oil will render the best service. If the bearing carries a heavy load and slides slowly, the heavy oil is best.

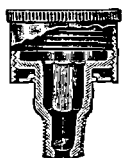


FIG. 9.—
Common grease cup.

The number of r.p.m. will determine the frequency with which lubricants should be applied. On a mower the main axle may not require oil more than once or twice during a day's operation, while the bearings on the crank shaft and pitman wheel need an application of oil every thirty minutes, at least.

Where greases or semisolid oils are used, the selection of the right grade of grease is important. Usually there are four grades: 1, 2, 3, and 4. The softest of these is No. 1, while the hardest is No. 4.

25. Grease Cups.—On farm machinery most of the slow-moving parts are lubricated by means of grease placed in cups which have threaded caps into which the grease is placed (Fig. 9). When the cap is screwed down upon the cup, the grease is forced into the bearing. Some of these caps have a device attached to prevent losing, but in the majority of cases they are simply screwed on.

The grease used should be comparatively soft, a No. 2 or 3, (never harder than No. 3) so that it can be forced through the small opening

¹ GILL, A. H., in Rogers and Amherst's, "Industrial Chemistry."

into the bearing. If a very hard grease is used, difficulty will be encountered in forcing it through into the bearing and in most cases insufficient lubrication will be the result. If a cup is placed upon the end of a long pipe through which the grease must be forced, it is very likely that the

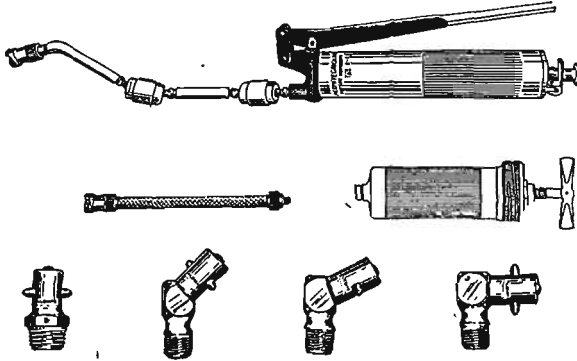


FIG. 10.—Alemite gat and hand grease guns, hose, and fittings.

grease within the pipe will dry out to such an extent that it will be impossible to force the grease through into the bearing. It is generally better, therefore, to have as short a distance between the grease cups and the bearings as possible.

26. High-pressure Lubrication.—With the great improvements and modernization of farm machinery has come a change in the handling of machinery by farmers who use it. Farmers today realize that equipment is no better than the care taken of it and that efficient farm machinery now manufactured is capable of long hours of service only when kept well lubricated and in good operating condition.

The greater speed acquired through more powerful tractor engines and pneumatic tires would be lost unless the servicing of the machinery was done quickly, thoroughly, and effectively. Faulty lubrication would also soon extract an eventual toll in the form of breakdowns that mean expensive repair bills and delays just when the machinery may be needed most.

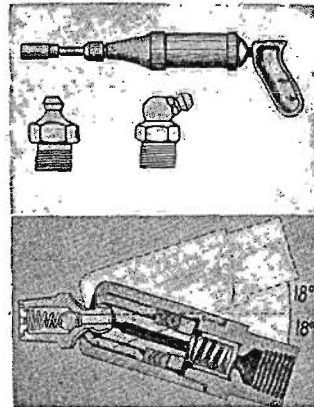


FIG. 11.—Hydraulic grease gun and fittings, showing cross-section of nozzle and fitting.

Farm machinery manufacturers realize the importance of good lubrication and are now equipping most farm machines with either Alemite (Fig. 10) or hydraulic fittings (Fig. 11). A survey of 5,000 farms has disclosed the use of 433 high-pressure fittings on the machinery on the

FARM MACHINERY AND EQUIPMENT

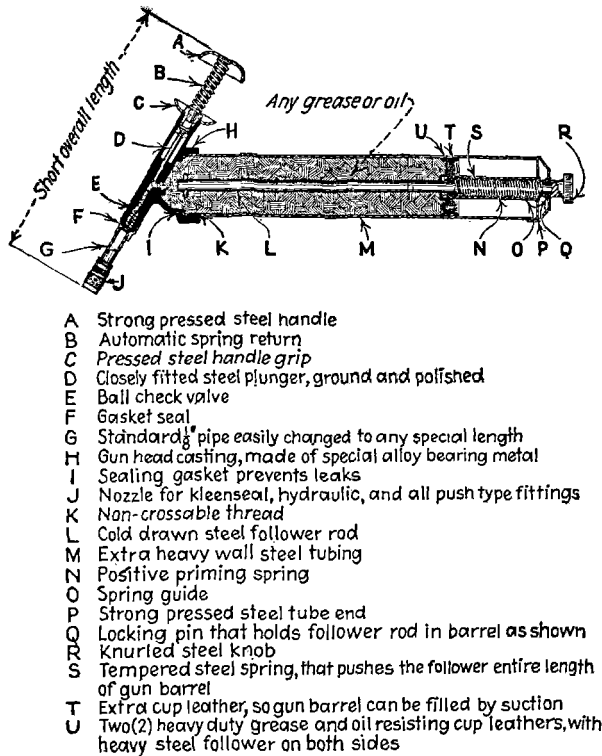


FIG. 12.—Cross-section of Lincoln grease gun.

average 80-acre tractor farm.¹ These fittings are distributed on the various machines as follows:

	Fittings		Fittings
Tractor.....	20	Ensilage cutter.....	25
Tractor plow.....	12	Hay rake.....	12
Sulky plow.....	10	Hay loader.....	38
Disk harrow.....	12	Cultivator.....	12
Mower.....	7	Grain drill.....	30
Corn planter.....	10	Farm wagon.....	6
Windmill.....	2	Feed grinders.....	8
Manure spreader.....	17	Pump jack.....	2
Grain binder.....	40	Corn binder.....	40
Thresher.....	70	Automobile.....	20
Corn sheller.....	15	Trucks.....	25

¹ Stewart-Warner Corporation, Alemite Division.

CHAPTER IV

MATERIALS OF CONSTRUCTION

The strength, durability, and service of a farm implement depend largely upon the kind and quality of the material used in building it. There is a tendency in the construction of implements to eliminate as many castings as possible and to use pressed and stamped steel. Where this is done, the cost of manufacturing machinery in quantities is materially reduced. The weight of the machine is also reduced but the strength and durability are retained and often improved. The success or failure of an implement frequently depends upon the material used in building it.

27. Wood.—Today iron and steel have practically taken the place of wood. There are perhaps two reasons for this: first, steel is more durable; second, it is becoming cheaper than good wood because of the scarcity of the latter. Many farm machines are defective because the wood used in their construction is not well cured and free from knots. The wood parts should be well painted.

28. Cast Iron.—Cast iron is iron containing so much carbon, or its equivalent, that it is not usefully malleable at any temperature. The amount of carbon varies from 2.2 to 4.3 per cent, depending on the amount of silicon, sulphur, phosphorus, and manganese.

There are two grades of cast iron—gray cast iron where the carbon is segregated from the iron in the form of graphite, and white cast iron which has carbon and iron combined. Another grade is often mentioned, mottled cast iron, which is a mixture of the gray and white. Cast iron is made by combining pig iron and scrap iron and pouring the molten metal into sand molds of the desired shape, where it is allowed to cool before it is cleaned and made ready for use.

Cast-iron castings are generally large, bulky, very brittle, and cannot be hammered to any great extent without breaking. They cannot be forged but can be cemented together by brazing or welding. The brazing process is accomplished by heating the broken parts to a welding heat and applying a brazing compound. Welding is accomplished by using an oxy-acetylene gas flame.

29. Malleable Cast Iron.—Malleable iron is annealed white cast iron in which the carbon has been separated from the iron without forming flakes or graphite as in the gray cast iron. It will bend to a limited extent without breaking.

The process of making malleable cast iron consists of melting the white pig iron, with scrap, in the furnace and pouring rapidly into sand molds while very hot. After cooling, the castings are cleaned and made ready for annealing. The annealing pots are usually of cast iron. The castings are packed in these pots along with iron scale (iron oxide) which acts as a decarburizer and causes much of the brittle quality to disappear. The annealing pots containing the castings and iron scale are placed in an oven and the temperature raised to a cherry-red heat, about 1450° F., and held there from 3 to 5 days, depending on the size of the castings and the amount of decarbonizing desired. Then, the furnace is allowed to cool slowly for a few days before the castings are removed and cleaned. Malleable cast iron is used extensively in building farm machinery and for various kinds of hardware.

30. Chilled Cast Iron.—Chilled cast iron is cast iron poured into molds which have a part of the mold made of metal instead of sand. This metal causes the molten iron, that comes in contact with the metal, to cool more rapidly than the balance of the casting, thus forming a hard surface. The metal portion of the mold must be heated to a temperature of about 350° F. before pouring to prevent explosions when the hot metal strikes the cold. Chilled cast-iron moldboards for plow bottoms show that the iron fibers are brought perpendicular to the surface where the metal is chilled.

31. Wrought Iron.—Wrought iron is nearly pure iron, with some slag, and is used in forge work as it is readily welded and easy to work. Wrought iron has very little carbon in it, ranging from 0.05 to 0.10 per cent. It is expensive, however, and a mild steel is used to a considerable extent in place of it. The commercial form is obtained by rolling the hot iron into bars or plates from which nails, bolts, nuts, wire, chains, and many other products are made.

32. Steel.—Steel is a variety of iron classed between cast iron and wrought iron, very tough and, when tempered, hard and elastic. The hardness of steel is determined principally by its carbon content but is influenced by the percentage of manganese, phosphorus, and sulphur. The American Society of Automotive Engineers has a numeral index system which is used to identify the composition of the various grades of carbon, manganese, nickel, molybdenum, chromium, chromium-vanadium, and tungsten steels. For example, a mild carbon steel carries an A.S.E. No. 1020 and contains 0.15 to 0.25 per cent of carbon. A medium carbon steel is numbered 1045 and contains 0.40 to 0.50 per cent of carbon. High carbon spring steel is A.S.E. No. 1095 and contains 0.90 to 1.05 per cent of carbon. In manganese, nickel, molybdenum, and other steels extra percentages of these elements are added to impart toughness and other special properties.

32a. Structural Steel.—Structural steel comes in the form of angle irons, I-beams, channels, tee bars, round and square rods, tubes, plates and strips, as shown in Fig. 13. The steel used in these pieces is made by one of two processes; open-hearth, and Bessemer. The former process gives the best grade of material, but is more expensive; hence, we find in agricultural machinery the latter kind being used. The steel is first made into large bars and then rolled into the various shapes.

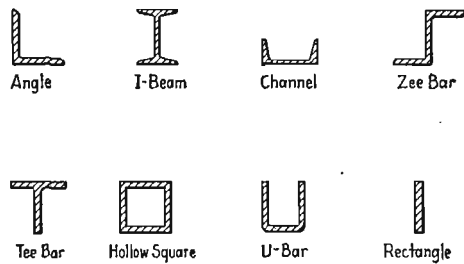


FIG. 13.—Types of structural steel.

33. Soft-center Steel.—Soft-center steel consists of three layers of steel, as shown in Fig. 14; two layers of hard steel placed on the outside and welded to an inner layer of soft steel. In this manner a hard surface is obtained without brittleness. Soft-center steel is used on plow bottoms.

34. Case-hardened Steel.—This steel closely resembles soft-center steel since the outer surfaces are hardened leaving a soft center (Fig. 15). It is made by heating soft or mild steel in contact with carbon so that the carbon will penetrate the outer skin, making a high-carbon steel

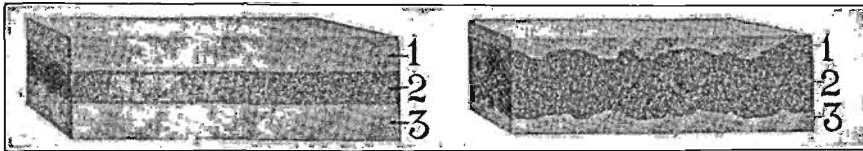


FIG. 14.—Soft-centered steel.

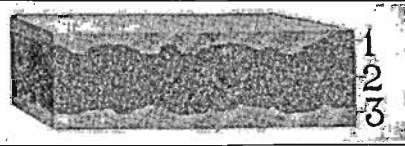


FIG. 15.—Case-hardened steel often passed as soft-centered steel.

surface which is very hard. The objection to this type of soft-center steel is that the hardened surface is not of uniform depth. The surfaces of cams are usually case hardened.

35. Cast Steel.—Cast steel is a steel that is cast. It can be secured in varying degrees of hardness and makes a more durable casting than the best grade of cast iron. It is used mostly in gearing. Not much of it is found in agricultural machinery.

36. Brass.—Ordinary brass is an alloy of copper and zinc. Some commercial brasses contain small percentages of lead, tin, and iron. The percentage of copper in brass may range from 60 to 90 per cent, and the percentage of zinc from 10 to 40 per cent.

37. Bronze.—Bronze is an alloy of copper and tin. However, zinc is sometimes added to cheapen the alloy or change its color and increase its malleability. The percentage of tin in bronze may vary from 5 to 20 per cent. Phosphor-bronze, manganese bronze, and aluminum bronze are special copper alloys containing small percentages of tin, zinc, or aluminum.

38. Babbitt.—Babbitt is a tin-base alloy containing small amounts of copper and antimony. Good babbitt for automobile bearings should contain 7 per cent copper, 9 per cent antimony, and 84 per cent tin.

39. Solder.—Common solder contains about one part tin and one part lead. Hard plumber's solder contains two parts tin and one part lead.

HEAT TREATMENTS OF MATERIALS

Heat treatment is a term used when heating and cooling processes, through a range of temperatures, are applied to steel to improve the structure and produce desirable characteristics. Such treatments include annealing, hardening, tempering, and case-hardening.

Plow beams, disk plow, and disk-harrow blades are examples of parts of agricultural machines that are heat treated in order to make more serviceable implements.

CHAPTER V

TRANSMISSION OF POWER AND ELEMENTS OF MACHINES

It is not always possible to transmit power by one continuous shaft directly from the source at which it is generated to the point where it is consumed. It is necessary, therefore, to have some other means by which power can be transmitted in order that work may be done. The principal methods used are belts in connection with pulleys and shafts, sprockets and chains, gears, triangles, and electricity.

In the study of farm machinery it is necessary to notice a good many points that cannot always be brought out in the discussion of the individual machine. These elements of a machine include such things as bearings, bushings, gears, clutches, and the various minor parts that will have an influence on the value and the lasting qualities of the machine.

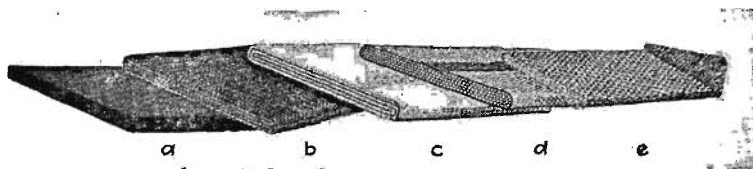


FIG. 16.—Different kinds of belting:
a, leather; b, stitched canvas; c, balata; d, rubber; e, solid woven.

40. Belts.—Whenever it is necessary to transmit power some distance between shafts or from some point where it is not possible to use a set of gears, belting is used. The purpose of a belt drive is to carry a certain amount of power from one revolving pulley to another. Then, a good definition for a belt may be given as follows: A belt is any flexible material placed around two pulleys, having a certain amount of tension, to transmit the power from one pulley to another. Such a definition, of course, includes ropes and chains, since they are of flexible material, but in the true sense of the word, we always think of them as “chain belts” or “rope belts,” and the term *belt* is always applied to the flat strand of leather, rubber, canvas, or other similar material stretched on pulleys.

41. Kinds of Belts.—The different kinds of belts used by the average farmer are leather, rubber, canvas, and woven cotton (Fig. 16). It is generally considered that the leather belting is the best type that can be secured. It is also the most expensive, but has longer life than any of the other kinds, if it is given proper care and protection.

42. Leather Belting.—Leather belting should be used only under the best conditions, that is, it should be kept dry and in a protected place, free from grease, dirt, and oil. Leather belting may consist of single leather which is one thickness or double leather belting composed of two thicknesses cemented together. Double leather belts are made for special purposes and can be used to advantage only over extra-large pulleys. It is generally advisable to use single leather belting if one, or both, of the pulleys is less than 12 inches in diameter and double leather belting where both pulleys are over 12 inches in diameter. Where the belt has been spliced, it should be placed on the pulley to run in such a direction that the *thin edge* of the splice will be on the *inside of the belt*, and for the first part of the splice to run over the pulley. The splice of the double belt should run with the thin edge pointing away from the direction of travel.

In placing leather belts on the pulley always place the *hair side* next to the pulley for this gives less slippage. It is considered that the softest part of the belt is on the flesh side and when run in this manner the flesh side is not so liable to crack as the hair side of the belt. Then, the hair side is much smoother and more friction can be obtained between the belt and the pulley surface—thus eliminating, to a large extent, slippage. Jones¹ found that the hair or grain side would transmit from one to three times as much power as the flesh side, depending on the belt, the tension, and the condition of service.

43. Rubber Belting.—The next best type of belt that can be secured is the rubber belt (Fig. 16). It has uniformity in thickness, will stand variation in temperature without being injured greatly, and is not affected when exposed to action of steam and water. There is not so much belt slippage as in the case of the leather belt, hence, less tension is required and the bearings of the machine are not subjected to such heavy strains. It wears out more rapidly, however, especially if the edges are rubbing against any object. It also has a disadvantage in that it will stretch and the distance between the pulleys will have to be regulated or the belt cut and relaced for good operation. The foundation of rubber belting consists of cotton ducking which is specially treated with a rubber compound. The compound is applied and forced into the ducking by pressure. The whole is then vulcanized and placed under a very heavy pressure which removes all superfluous stretch and unites the rubber and duck into one inseparable body. It is generally considered that a three-ply rubber or a four-ply cotton belt is equal in strength to a single-ply leather belt and a six-ply rubber belt is equal to a double leather belt.

¹ The Leather Belting Exchange.

In the making of the rubber belt the layers of canvas 'ducking' are often folded over and stitched along the edges. The vulcanizing of the rubber to the canvas is supposed to hold the central part of the belt together; however, this is not always effected. If the edge of the belt happens to rub against the tractor wheel, axle, or some other object and wears the stitching away, one complete fold of the belt may hang loose. When this happens, the life of the belt is shortened.

44. Canvas Belting.—Canvas belting (Fig. 16) is made up of layers of canvas stitched together through the center as well as along the edge. It



FIG. 17.—Cross-sections of two makes of V-belts.

is a cheap belt and is used where rough handling is expected. It is not adapted for use over pulleys having fixed distances between them but should be used where distance between pulleys can be adjusted with little difficulty; for example, running threshing machines, ensilage cutters, and similar machines. A four-ply canvas belt is of the same strength as a single-ply leather belt. A thick heavy canvas belt should never be used on small pulleys.

45. Solid Woven-cotton Belts.—The woven-cotton belt (Fig. 16) instead of being made up of layers of canvas ducking is woven somewhat

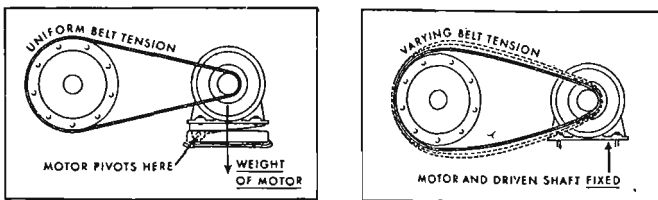


FIG. 18.—Effect on tension of V-belts by pivoted and fixed motors.

in the same manner as an ordinary lamp wick. It is made in various widths and weights, proportional to the service required. It is treated with a special material to withstand friction, dirt, and atmospheric conditions.

46. V-belts.—V-belts are so named because of their shape (Fig. 17). The pulley for this type of belt has a V-shaped groove (Fig. 19) to fit the belt. The V-belts proved their serviceability as fan belts on automobiles, and as a result they have been adapted for use on many farm conveniences and some farm machines. Recently a combine harvester-thresher was equipped with V-belts and adjustable pulleys. Fans on feed mills are driven with a series of from three to four V-belts. Less slippage

is encountered when V-belts are used in grooved pulleys than with flat belts on crown-faced pulleys.

47. Belt Lacing.—The most common type of belt lacing for ordinary farm usage is the leather lacing. There are several methods of lacing belts which consist of a single straight lace, double straight lace, and double hinge lace. The following are good rules for lacing belts: First, for belts 2 to 10 inches wide, place the holes $\frac{1}{2}$ to $\frac{3}{4}$ inch from the side and $\frac{1}{8}$ inch from the end of the belt. The second row should be at least $1\frac{3}{4}$ inches from the end. For wider belts these dimensions should be even greater, the longer diameter of the holes being parallel with the side of the belt. Second, holes in rubber and

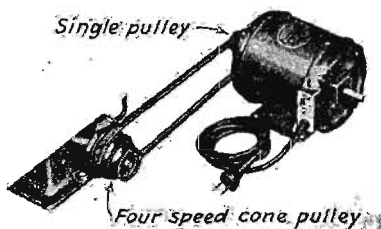


FIG. 19.—V-belt drive using a four-speed cone pulley.

in the different types of canvas belts should be made with a sharp belt awl. Holes in leather belts should be made with an oval punch. Third, for light work with large pulleys use the single straight lacing. Fourth, for heavy work with large pulleys use the double straight lacing. Fifth, for lacing rubber and canvas belts doing heavy work on large or small

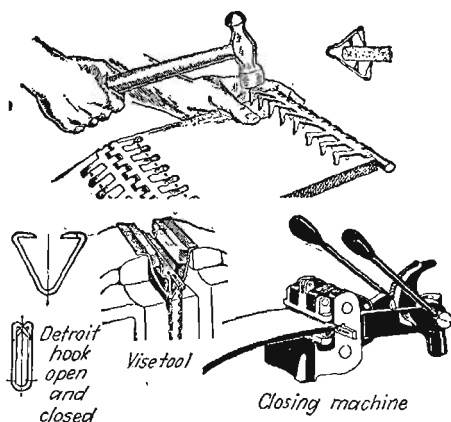


FIG. 20.—Methods of closing metal belt laces: Alligator above, Clipper below.

pulleys use the double hinge lacing. Sixth, the straight part of the lacing should always be on the pulley side of the belt. Metal laces for small belts transmitting a small amount of power are quite satisfactory. Figure 20 shows two types of metal belt laces.

48. How to Lace a Belt.—Figure 21 shows a simple method of lacing an ordinary belt. Begin in the middle of the belt, lace to the edge, then back to the middle. The ends are fastened in the middle. Beginning on

the pulley, or hair side, put one end of the lace through hole 1 from hair side to the flesh side. Put the other end of the lace through hole 2 from hair side and draw tight. Pass long end of lace diagonally across the joining and through hole 3. From hole 3 pass lace straight up on hair side and through hole 4; then, diagonally down on flesh side and through hole 5; then, straight up on hair side to hole 6, down on flesh side to hole 7; up on hair side to hole 8, down diagonally on flesh side to hole 9; straight up on hair side to hole 10, and diagonally down on flesh side to hole 11. Continue in the same way, placing the lace through the various holes in order.

49. Belt-creep and Slip.—When a belt is running under a load, it is impossible for 100 per cent of the power available at the driving pulley to be delivered to the driven pulley. There is a slight difference in the r.p.m. of each of these pulleys which is due to the slipping of the belt. When transmitting power, there is a tight and a slack side to the belt. The tight side stretches while the slack, in turn, contracts. The section passing on to the driving pulley is slightly longer than when passing off. The reverse is true at the driven pulley. The change in length takes place while the belt is on the pulleys and it is called *creep* which should not be confused with slip.

50. Some Useful Rules on Belts.—To find the horsepower a leather belt will transmit: If V equals velocity of belt in feet per minute and W equals width of belt in inches; for a single belt, horsepower equals $VW/1,000$ and, for a double belt, horsepower equals $VW/550$.

To find the length of a belt for two pulleys: Add the diameters of the two pulleys together, divide this sum by 2, multiply this quotient by $3\frac{1}{4}$ and to this product add twice the distance between shafts.

To calculate the speed or size of pulley: the r.p.m. of the driving pulley times its diameter equals the r.p.m. of the driven pulley times its diameter. If three of the quantities are known, the fourth can be easily determined. $S \times D = S_1 \times D_1$ where S = r.p.m. and D = diameter.

The speed of the belt can be determined by multiplying the circumference of the pulley by the number of revolutions at any given time. This disregards slippage and creep. The speed of the belt should not exceed 5,000 feet per minute. A good speed is around 3,500 to 4,000 feet per minute.

51. Some General Precautions as to the Use of Belts.

1. Belts which are too tight cause injurious strains on the belts and machinery which result in hot boxes and broken pulleys.
2. Belts which are too loose have a flappy unsteady motion.

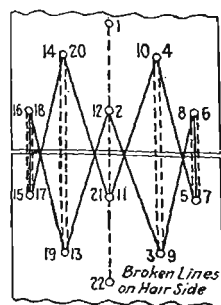


FIG. 21.—Method of lacing a belt.

3. Keep all belts free from dirt and moisture.
4. Mineral oils should not be used on leather and rubber belts.
5. Boiled linseed oil or resin mixed with tallow and oil makes a good belt dressing.
6. Belts should be run horizontally or as nearly so as possible.
7. The lower side of a belt should be the driving side as it gives a greater arc of contact (Fig. 22).

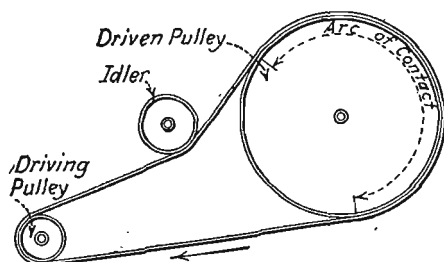


FIG. 22.—Method of placing idler on a belt; the tight side of the belt should be on the bottom.

8. Idler pulleys should be placed on the slack side of the belt and nearer to the driven pulley (Fig. 22).
9. Have the arc of contact 180 degrees and over if possible (Fig. 22).
10. A pulley that is too narrow should never be used.

52. Care of Belts.—The United States Department of Agriculture, *Farmers' Bulletin* 1183, gives the following on the care of belts:

Satisfactory service cannot be expected from a belt that is too light or too heavy or otherwise not adapted to the work. Neither can a belt be made to give satisfactory results if the slips do not run true; is not properly laced; is run too loose or too tight; is subjected to alternating light and heavy loads; is alternately wet and dry; is run on pulleys of the belt; or neglected and allowed to deteriorate for lack of grease and belt dressing. Unless frequently wiped off dust and dirt work into the belt and damage it. Never let the belt remain dusty or dirty over night nor leave an excessive amount of grease or oil on it.

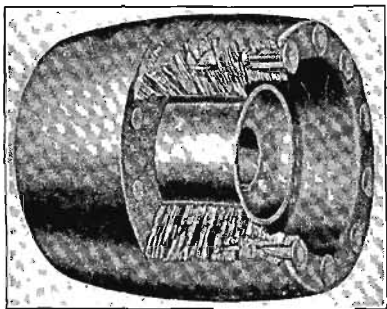


FIG. 23.—Rockwood pulley.

The best leather-belt dressings are mixtures of cod and neat's-foot oils with tallow and wool grease free from mineral acid.

53. Pulleys.—Pulleys for agricultural purposes are manufactured from wood, cast iron, and pressed paper. Cast iron is the most popular type at the present time due to the greater strength and freedom from joints. Where the pulleys are of large diameter, not exposed to steam or water, and where slow speed and light power are required, wood is still extensively used. Size for size the wooden pulley is perhaps a little

cheaper, but the transmission of power by the cast-iron pulley will cost less. A special type of pulley known as the *Rockwood* pulley (Fig. 23) is popular for use on machines that run at a high speed.

Figure 24 shows an adjustable pulley where the speed of the driven machine can be either increased or decreased by varying the distance

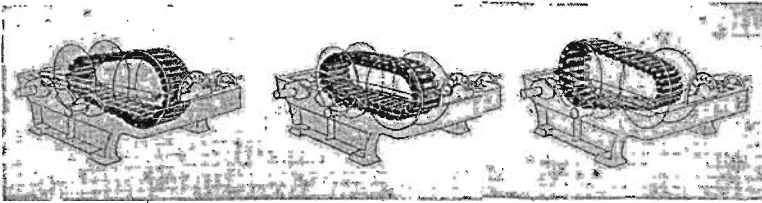


FIG. 24.—Variable-speed pulley.

between the sides of the V-pulley. This changes the arc of contact between the pulley and the belt, thus varying the speed.

54. Method of Constructing Pulleys.—There are the following types of pulleys: solid, split, and split-hub.

The *solid pulley* is one that is cast in a solid piece, having setscrews and keys to fasten it to the shaft. It is better balanced in weight than the other types, but has the disadvantage of having to be slipped on over

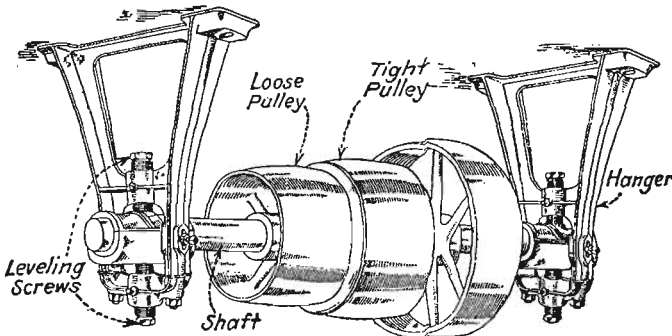


FIG. 25.—Line shaft showing hangers, tight and loose pulleys.

the end of the shaft to the position required. If the shaft is already up and another pulley is needed, the removal of all pulleys and collars may be necessary to get it in place. Solid cast-iron pulleys cannot be used to any advantage with a different size of shafting than that for which they were bored.

The *split pulley* is cut into halves which are held together by bolts. This type of pulley may be had in either wood, cast iron, or steel. The halves are built separately, fitted together, and then finished as a solid pulley. This type of pulley depends upon the binding effect of the

bolts to prevent turning on the shafts. Often a key or a setscrew is added to aid the bolts. Such a pulley can be put on at any place on the shaft without disturbing the equipment previously installed.

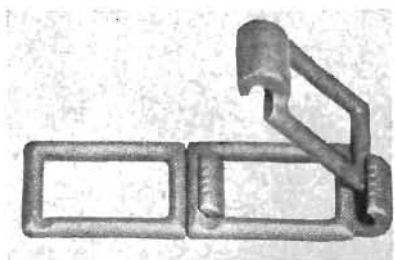


FIG. 26.—Malleable-iron hook chain showing how to separate links.

on gas engines and for power pulleys such as are used on threshing machines.

The *split-hub pulley* is a solid pulley having its hub split but not the pulley face. It has about the same disadvantages as the solid type. The split hub allows slight adjusting for different size shafts. There are bolts through the hub which clamp the pulley on to the shaft. This type is not much used, except at the ends of shafts,

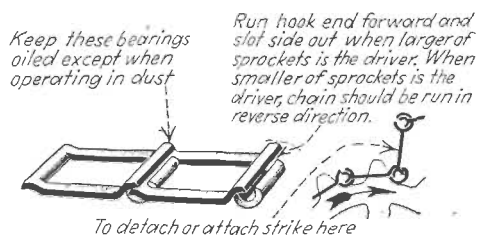


FIG. 27.—Pressed-steel hook chain.

The center of the pulley face is generally slightly larger in diameter than at the edges and is called *crowned* (Fig. 25). Since there is a slightly larger diameter at the center than at the edges, a greater centrifugal force and a greater speed is given, causing the belt to hang to the point of larger diameter— the center of the pulley.

Many pulleys, where the belts need guiding, are built with a flange on one side. The flanged edges should be rounded to prevent cutting the belt in case it runs up over the flange.

55. Line Shafting.—The shaftings on agricultural machinery are usually made from cold-rolled steel which comes from the mill in the finished form. The factories cut it into the required lengths, milling keyways wherever needed

A *Line Shaft*, as shown in Fig. 25, consists of a long continuous shaft supported by *hangers*. Arranged upon this line of shafting are pulleys for transmitting power to separate machines. The hangers for shafting should not be placed over 8 feet



FIG. 28.—Detachable pintle chain.

apart. The size of the cold-rolled shafting to be used can be determined by a formula. It usually is a better plan, however, for average farm conditions, to give the dealer the amount of horsepower to be transmitted and he will furnish the proper size of shafting needed.

The *journal* of a shaft is that part which is in contact with the bearing.

56. Power Transmission by Sprocket and Chain.—Where power is to be transmitted at low speed, chain or link belting is very useful. There is no slippage when a chain belt is used and much more power can be transmitted for short distances than with an ordinary type of belt. When the links and the teeth on the sprocket wheel begin to wear, however, there is a tendency for the chain to ride the sprocket teeth and sometimes to jump off entirely. Figures 26 to 29 show the kinds of chains in common use for transmitting power. They are made from either malleable iron or steel. Where the links are held together by

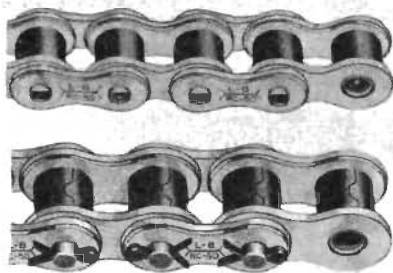


FIG. 29.—Two types of roller chain.

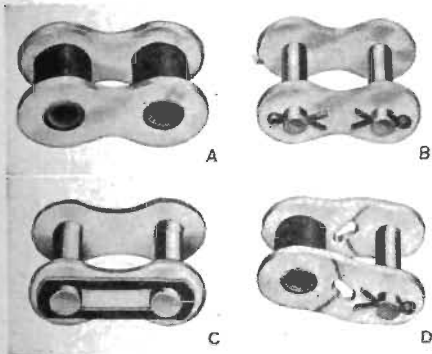


FIG. 30.—Roller chain parts: A, inside roller link; B, connecting outside link; C, spring clip connecting outside link; D, offset or half link.

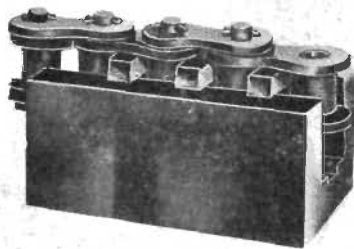


FIG. 31.—Roller chain repair block.

pins or rivets it is called a *pinle chain* (Fig. 28). Such chains are usually made of malleable iron. If there is a roller fitting over the pin to form a sort of bushing and to serve as a wearing surface, it is called a *roller chain* (Fig. 29). This is really the better type of chain to use since it partly substitutes rolling for sliding friction and also distributes the wear over a larger surface, running a longer time without giving trouble. It is also used for transmitting power at high speeds. The *hook chain* may be made of either malleable iron or crimp steel (Figs. 26 and 27). The links

have a hook on one end which slips over the end of the next link and so on until the chain is completed. When such a hook chain is used, no matter whether it is steel or malleable iron, the hook should run with the open part away from the sprocket wheel and leading in the direction of travel, as shown in Figs. 26 and 34). Chain belting should be run fairly loose. Undue tightness simply wastes the power and cuts down the life of the chain. Some form of chain tightener should be used with all chain belts. These tighteners may be either a slide, smooth wheel, or a sprocket wheel. They may be either fixed or held against the chain by a spring.

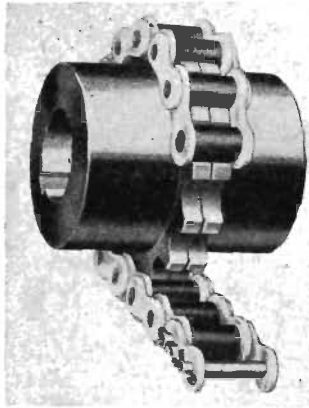


FIG. 32.—Flexible coupling using roller chain to connect the coupling halves.

57. Transmission of Power by Gears.—

Where the machine is rather compact and the shafts are close together, gears may be employed to transmit the

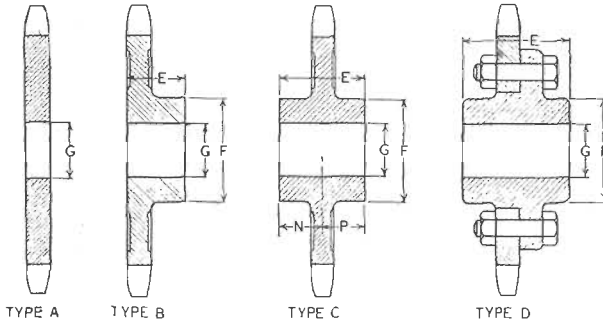


FIG. 33.—Types of sprockets.

power, as shown in Fig. 35. The type of gear may be either spur, bevel, worm, bell, or helical.

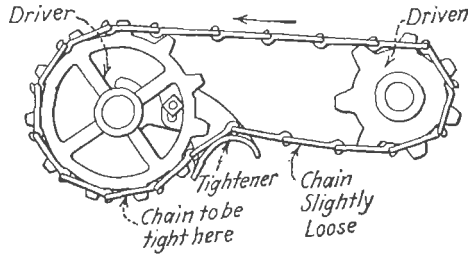


FIG. 34.—Illustrating the proper method of running a hook chain on the sprockets.

Often there is a combination of either spur or bevel or other type. If the power is transmitted parallel to the shaft, helical, bell, or spur

gears are employed; but if the shafts are at right angles, the bevel or worm gear must be employed. The use of gears makes a more substantial construction and eliminates a great amount of lost motion; however, the cost is greater, especially in the case of repairs. It is much cheaper to replace one or two links in a chain than to replace a complete gear. When one tooth is broken and all the others remain, the gear cannot be used.

58. Transmission of Power by Triangles.—It is often desirable to transmit power some distance from the point where it is generated as in the case of operating a pump by a windmill which is not over the well. The method used to handle this situation is to have a cross-arm or rocker arm at both the source of power and at the point to which it is distributed. At each end of the cross-arm a wire

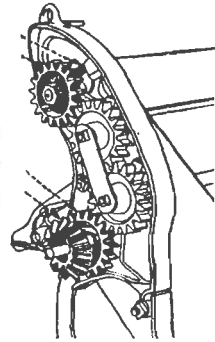


FIG. 35.—Transmission of power by gears.

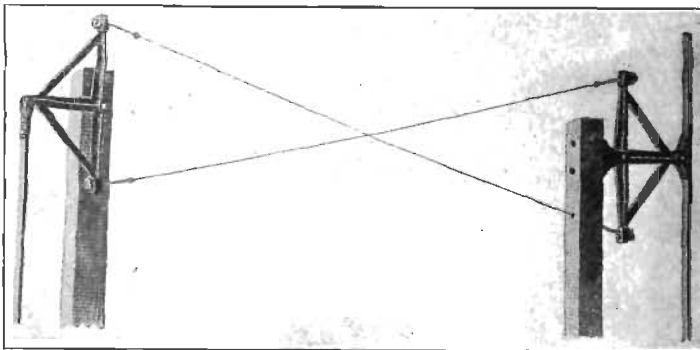


FIG. 36.—Transmission of power by triangles.

is attached extending to the opposite end of the other cross-arm, causing the two wires to cross about halfway between, as shown in Fig. 36. The lifting stroke of the pump comes at the same time the pull comes at the windmill and thus prevents buckling of the parts. If power is transmitted from a gas engine, it is not necessary that the wires be crossed. By the use of triangles, a series of pumps may be operated by one engine.

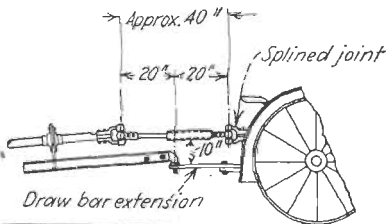


FIG. 37.—Double universal joint used on the power-take-off to operate tractor grain binder.

59. Universal Joints.—Where machines are operated from the power-take-off of tractors, universal joints are installed on the power shaft to permit the machine to be adjusted and to turn corners. A telescoping

section (Fig. 37) is usually placed between two universal joints, as the distance between the tractor and the machine varies when turning and moving over uneven ground.

60. Electrical Transmission of Power.—In many parts of the country electrical companies have made electrical power available to rural districts. In such cases the electricity is generated at some central source and transmitted over wires to the various farmsteads where it is used for

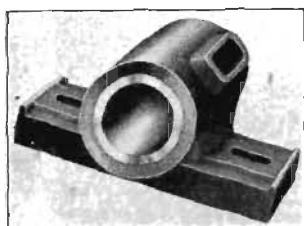


FIG. 38.—Solid bearing.

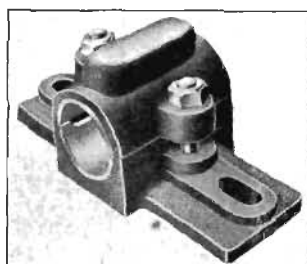


FIG. 39.—Plain or split bearing.

lighting purposes and running electrical motors to accomplish many types of work. Where the farmer owns his own individual light plant, it will be found that electricity can be used to an advantage to furnish not only light but power as well for small jobs around the farm home.

61. Bearings.—In all farm machinery, bearings of various types are used. *The proper bearing to use is determined by: the amount of wear, the speed at which the shaft is turning, the load it must carry, and the*

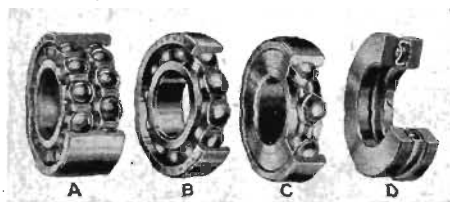


FIG. 40.—Types of ball bearings: A, double-row; B, single-row; C, single-row, with ring seal; D, end thrust bearing.

amount of end thrust. One type of bearing may give better service under certain conditions than another. Bearings are divided into the following types: solid, plain or split, ball, roller, and self-aligning.

Solid Bearings.—The simplest type of bearing is known as the *solid bearing* and is shown in Fig. 38. It consists of a piece of wood or cast iron with a hole bored through it large enough for a shaft to be placed in and revolve. Some of the better types are provided with bushings which can be removed and new ones put in. They are non-adjustable. The pitmans of grain binders have solid bearings.

Plain or Split Bearings.—When the bearing is cut into two parts, as in Fig. 39, either horizontally or at an incline, and the upper part bolted to the lower part, it is called a *cap* or *split bearing*. The upper part can be removed and the shaft lifted out of the bearing.

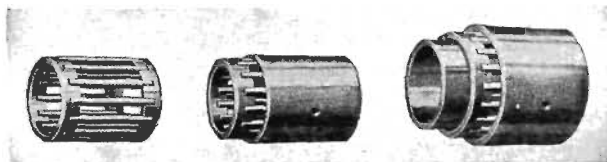


FIG. 41.—Parts of plain roller bearing.

Ball Bearings.—Ball bearings are bearings having one, or more, rows of small balls placed in a cage or holder. The balls are separated slightly and held in position by a retainer. Due to the small amount of surface that is in contact between the balls and the shaft, the friction is reduced to a very low point. Figure 40 shows ball bearings to take radial loads



FIG. 42.—Showing the various parts of two applications of Hyatt roller bearings.

and end thrust. Formerly, ball bearings were only used in farm machinery to take up the end thrust, but now they are also being used for main bearings on the cylinders of threshing machines, the mainshafts of feed mills and many other points.

Roller Bearings.—This type of bearing differs from ball bearings in that small cylindrical rollers are substituted in place of the balls. This

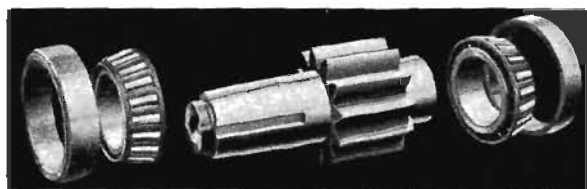


FIG. 43.—Application of Timkin taper roller bearing.

gives a much longer bearing surface which is necessary for a heavy load. There are also cages to hold the rollers apart as in the ball bearings. Figures 41 and 42 illustrate several types of roller bearings. Figure 43 shows the various parts of a taper roller bearing. This type is used largely on the heavy farm machines.

Self-aligning Bearings.—The construction of the self-aligning bearing (Fig. 44) calls for two separate units. The bearing proper, the part with which the shaft is in contact, and the shell or frame, in which it is

held, make up the two units and are commonly called the *ball and socket*. The socket or shell *C* is often divided into two parts, the lower and the upper, and is hollowed out on the inside to conform to the ball shape cast around the outside of the bearing proper at its middle. When in position the bearing unit is held securely in place, but because of the ball and socket

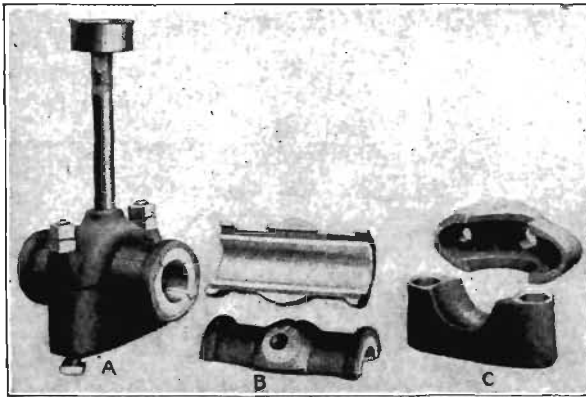


FIG. 44.—Self-aligning bearing: *A*, bearing assembled; *B*, inner unit; *C*, outer shell or socket.

construction, the bearing has a limited movement within the shell which permits it to align itself with the shaft if it should become twisted in the frame. Such an arrangement practically eliminates any tendency of the bearing to heat due to misalignment. If improperly adjusted, however, the swiveling action may be retarded and heating take place.

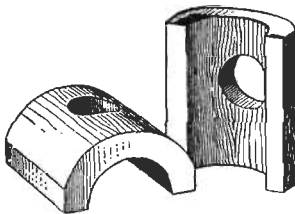


FIG. 45.—Wood bushings for bearings.



FIG. 46.—Oilless bushing.

62. Heating of Bearings.—Much loss of time often results from bearings becoming hot and in some cases to such a degree that the soft metallic lining melts, resulting in a burnt-out bearing. Some common causes of bearings heating are: lack of oil, cap too tight, belt too tight, and the collar on shaft too close against the bearing.

63. Bushings.—A bushing is the lining of a bearing and may consist of either bronze, babbitt, or wood.

Wood, being a cheap material, is often used in lining bearings where they are subjected to a considerable amount of sand and dust, causing rapid wear. Bearings on disk harrows (Fig. 45), in the majority of cases, are lined with wooden bushings. This allows frequent replacing of the bushings with small expense. Wooden bushings are usually made of maple which has been hardened by boiling in oil.

Bronze is an alloy containing about 80 per cent copper and 20 per cent tin. This metal gives a good, hard, wearing surface and is used extensively in bearings on farm machinery where the speed is rather high and the load heavy and heating likely to occur, such as the pitman box of the mowing machine and bearings for each end of the pitman shaft. This metal makes a very lasting material, wearing rather slowly if proper care is taken of the bearing by frequent oiling and keeping everything tight.

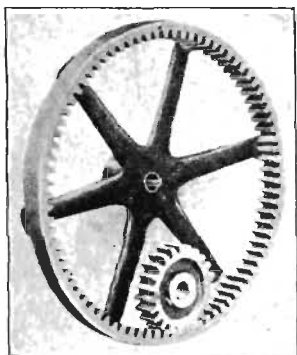


FIG. 47.—Internal spur gear.

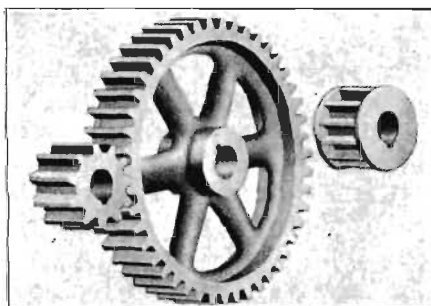


FIG. 48.—External spur gear.

Babbitt is an alloy of tin, copper, and antimony. This metal is also used to some extent in lining bearings on farm machinery. Babbitt can be easily melted and poured into a bearing. It is a rather soft metal but at the same time resists a great amount of wear. It must be well lubricated at all times or it will heat and melt.

64. Babbitting a Bearing.—First clean out the bearing; remove all old metal, grease, and dirt. Set the bearing on some solid place and level it. If the bearing is a plain one, wrap a piece of writing paper around the shaft; place the shaft in the center of the bearing and align it. If the paper is not placed around the shaft there will be difficulty in removing it from the bearing after the molten metal has been poured around it. If the bearing has a cap, place shims in between the cap and the base. At the end of the bearing, some clay, putty, or soap should be placed tightly around the bearing and the shaft to hold in the babbitt. Care should be taken to see that no water gets into the bearing proper. If there should happen to be some water in the bearing when the babbitt is poured

in, steam will form and the babbitt will be blown out. This hot babbitt will give a bad burn should it get on a person.

65. Gears.—It was pointed out on page 28 that gears were used for the transmission of power and consisted of the following types: spur, either internal or external; bevel; helical; and worm.

Spur gears are gears that have their shafts parallel. The teeth that go to make up the gear have their surfaces parallel to the shaft. An

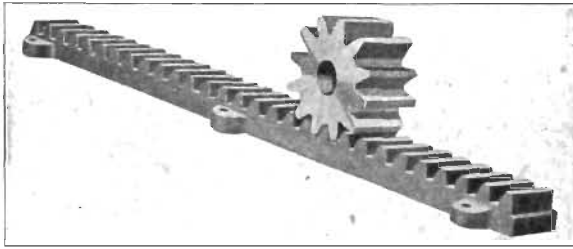


FIG. 49. Rack-and-pinion spur gear.

internal spur gear (Fig. 47) is one where the teeth are on the inside of the rim. If it has teeth on the outside of the rim it is known as an *external* spur gear (Fig. 48). With every internal spur gear it is necessary to have an external spur gear to operate it; but if there are two external gears, they may be used together without the use of an internal spur gear. Figure 49 shows a rack and pinion.

A *pinion* is the smaller gear of any two gears that are meshing together and it may be a spur, bevel, or helical gear.

Beveled gears (Fig. 50) have their shafts at right angles or nearly so.



FIG. 50.—Bevel gear and pinion.

Where the power has to turn a corner, beveled gears are used. The teeth are at an incline varying according to the difference in diameter of the gears meshing together. Beveled gears tend to wear so that their teeth do not fit one another closely and for this reason, there should always be some method of adjustment. Miter gears have an equal number of teeth cut at the same angle (Fig. 51).

Worm gears (Fig. 52) consist of screw-like threads which run spirally around a shaft. This is called the *worm* and meshes with a helical spur gear called the *sector*. As the worm turns, the teeth of the sector which fit in the screw, threads, or grooves are turned around slowly. This type of gear is used to a limited extent in farm machinery.

Helical gears (Fig. 53) may take the form of either spur gears or beveled gears, but they do not have straight teeth. The teeth are more or less curved so that they will remain in mesh or in contact longer than

the straight teeth. In the spur gear they are called *helical spur gear*; while in beveled type they are called *helical beveled gear*. When helical gears are used much noise is eliminated, due to the fact that the teeth remain in contact longer, giving an even constant pressure at all times.

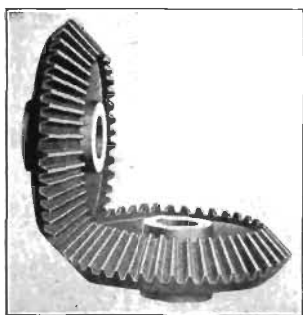


FIG. 51.—Miter gears.

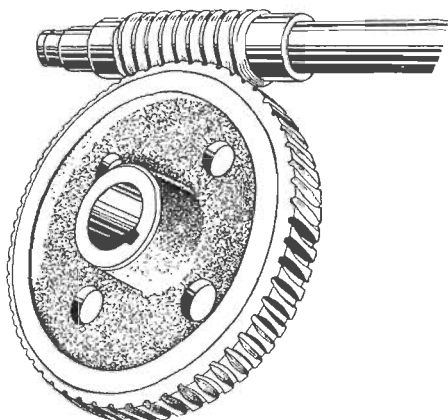


FIG. 52.—Worm and gear.

66. Clutches.—In most of the larger machines, for the farm, special arrangements must be made to disengage the power from the various working parts of the machinery, such as in mowers when moving from one field to another. It is not advisable, nor is it practical, to keep the cutting mechanism in constant motion; therefore, a clutch is arranged so that the drive wheel is allowed to turn without driving the cutting mechanism. There

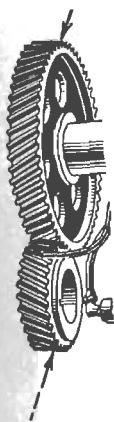
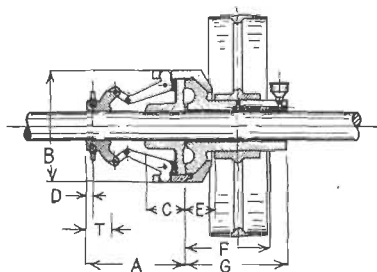
FIG. 53.—
Helical gears.

FIG. 54.—Cross-section of friction clutch.

are two different types of clutches in use on farm machinery; namely, *friction* and *positive*.

Friction clutches (Fig. 54) are used on line shafts but are not extensively used on field machines because of the rapid wear. They consist of two parts pressed together to such an extent that one will not slip upon the other. Both turn as a unit.

The positive type of clutch (Figs. 55 and 56) is the one used practically altogether on farm machinery. It consists of two parts which have teeth

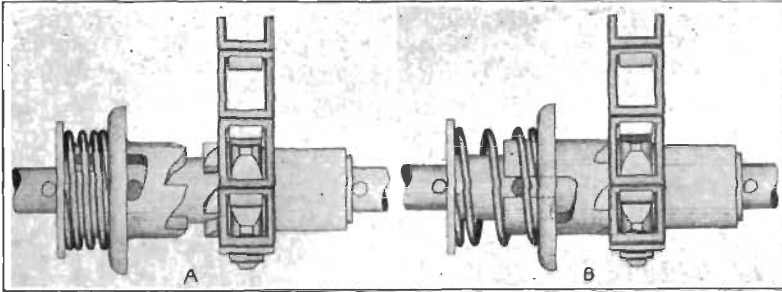


FIG. 55.—Positive type of clutch: A, clutch parts disengaged; B, clutch parts engaged to transmit power.

so that when they are brought together they engage instantly and positively allow no slipping. This type of clutch has the disadvantage of

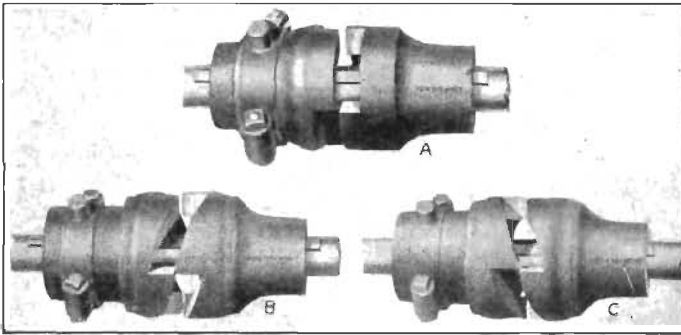


FIG. 56.—Types of positive clutches: A, square-jaw clutch coupling; B, left-hand spiral-jaw clutch; C, right-hand spiral-jaw clutch.

causing the various mechanisms of the machine to start at a high rate of speed, instantly, when the clutch is engaged, causing quite a bit of strain

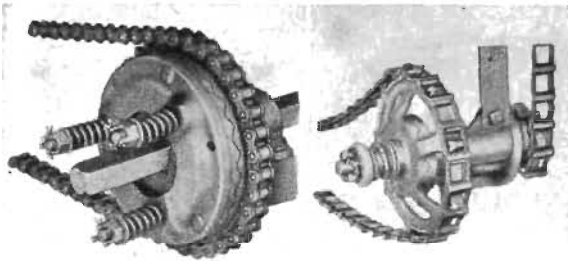


FIG. 57.—Two types of slip or snap clutches used on grain binders.

on various parts and may often cause breakage. The load cannot be eased on as it can be with the friction clutch which allows the machinery to start slowly and finally come up to the required speed.

Figure 57 shows a type of safety clutch that is being used on power-take-off machines. It is also used on bundle carriers for binders.

67. Cam.—A cam (Fig. 58) is a device that produces intermittent motion. When an object is in motion part of the time and at rest between motions, the action is said to be intermittent. A cam may best be described as a wheel with a hump or nose on one side (Fig. 58). The part of the cam that projects is called the *nose*. Anything resting against the cam will be moved only when the nose comes around to it; otherwise, it remains stationary. The arrangement shown in *A* Fig. 59 is made use of in power-lifting devices for plows, for agitators, and for ratchet drives, such as the operation of the apron of the manure spreader. It is called an *eccentric drive* when used to operate in both directions.

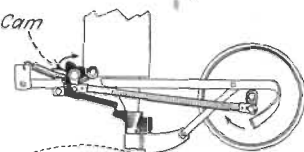


FIG. 58.—Cam used to operate furrow opener of planter.

68. Ratchet and Pawl.—A ratchet consists of gear-like teeth (*B* Fig. 59) placed in the form of either an internal or external spur gear. These teeth generally have an equal slope from the vertex of the teeth on each

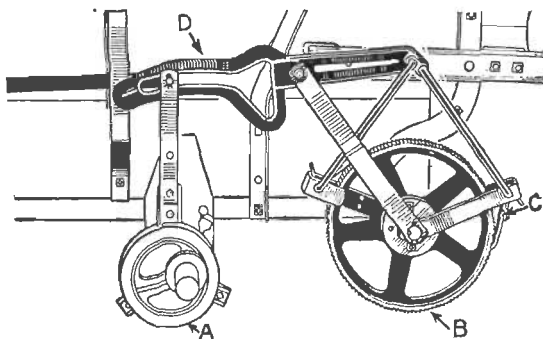


FIG. 59.—An application of an eccentric ratchet and pawl: *A*, eccentric; *B*, ratchet; *C*, pawl; *D*, rocker arm.

side, or they may take the form of a hook. The small pieces of cast iron or steel (*C* Fig. 59) that engage the teeth of the ratchet are known as *pawls*. The ratchets are always placed in such a manner that when the pawls, which are attached to the shaft by means of a pawl plate, mesh with the ratchet teeth, a force is exerted on the shaft causing the two to turn as a unit. If the ratchet is turning in the opposite direction, the shaft does not turn because the pawls slip over the teeth. The ratchet may be so designed to give power to the pawl or *vice versa*. Such arrangements are used where motion in one direction and none in the other is wanted. For example, wheels for mowers, manure spreaders, and grain drills.

69. Keys.—Keys are of two kinds: First, those that fit into a slot in both the shaft and pulley, holding the two firmly together and causing

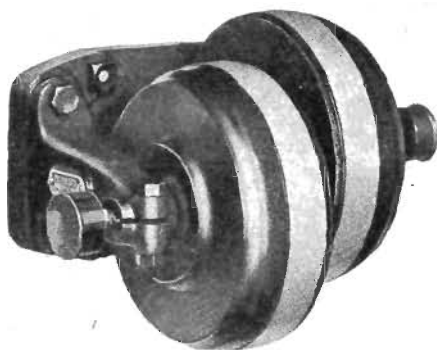


FIG. 60. —Patented drive to give an oscillating motion.

them to turn as a unit. Second, the cotter or split keys which are put through a hole in the end of a bolt or pin to hold the nut and washer on.

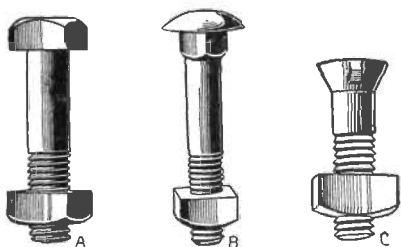


FIG. 61.—Types of bolts: A, machine bolt with nut; B, carriage bolt with nut; C, plow bolt with nut.

70. Bolts.—A great variety of bolts are used in the construction of farm machinery and may be classified as follows: machine, carriage, stove, and plow bolts.

Machine bolts are used for holding two pieces of metal together and have a square or hexagon head with the stem of the bolt fitting into the head without any change of diameter as A Fig. 61.

Carriage bolts (B Fig. 61), unlike the machine bolts, have a rounded or oval surface head having a square shoulder underneath extending out some half an inch, varying according to the size of the bolt.

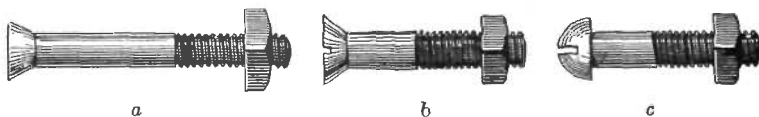


FIG. 62.—Tire and stove bolts: a, tire bolt; b, flat-headed stove bolt; c, round-headed stove bolt.

Plow bolts may have many different kinds of heads, but practically all of them have from 1 to 4 shoulder-like points which fit into a groove prepared for them in whatever material they are placed. The underside

of the heads of plow bolts are always countersunk (C Fig. 61), so that the head may go deep enough into the material that it will fit flush with the surface. Such bolts are used for holding plow shares.

Stove bolts, as shown in Fig. 62, are rather short bolts having threads running down close to the head which may be either flat or round heads. Most of the stove bolts also have a slot cut across the heads so that screw drivers may be used to prevent them from turning. This type of bolt is used for bolting thin metal together.

Tire bolts (Fig. 62) are used to hold wagon and carriage tires on the felloe of the wheel.

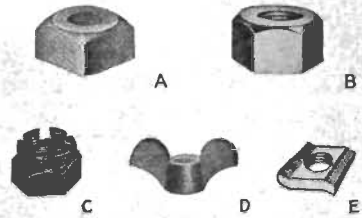


FIG. 63.—Nuts: A, square nut; B, hexagon nut; C, castellated nut; D, wing or thumb nut; E, square lock nut.

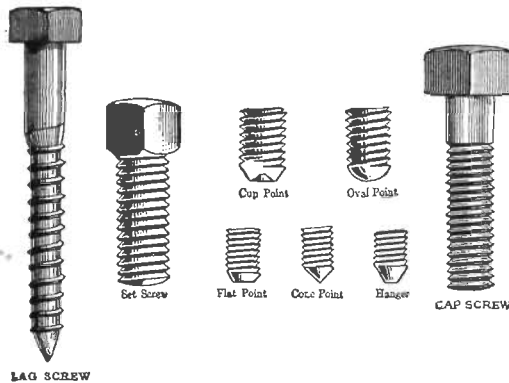


FIG. 64.—Types of screws.

71. Nuts.—The most common types of nuts used on farm machinery are shown in Fig. 63. The square nut is used on the cheaper machines, but the hexagon nut is used on the higher class machines. Castellated nuts are used where vibration is likely to cause the nut to work loose. Wing nuts are used where it is necessary to remove a part frequently. Lock nuts are constructed so that they automatically lock themselves in place.

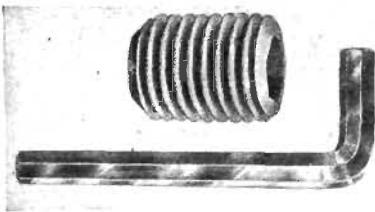


FIG. 65.—Hollow head setscrew and wrench.

72. Screws.—Many types of screws are also used in the construction of farm machinery and may be classified as follows: set, cap, lag, and wood.

A *setscrew* (Fig. 64) may have several different shapes for the point. They are so-called because they extend through the collars allowing

the point to come in contact with the shaft in order that the collar and shaft will be fastened rigidly together and turn as a unit. They are also used in the same way to prevent various parts from moving out of place.

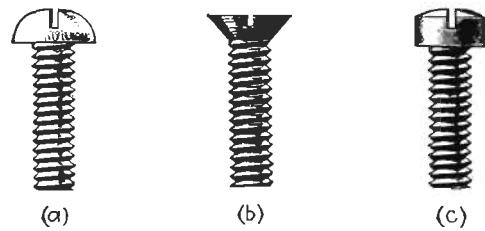


FIG. 66.—Machine screws:
a, round head; b, flat head; c, fillister head.

Cap screws (Fig. 64) may have square, hexagon, flat, and button types of heads. Such screws resemble closely a machine bolt with the exception

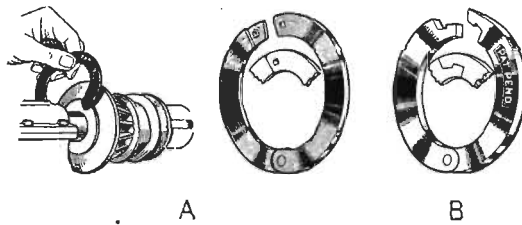


FIG. 67.—Quick repair washers: A, side latch; B, over latch.

that they do not have a nut on the threaded end; instead, the end passes through whatever it is to hold into a threaded hole which serves as a nut. For example, the cylinder head of an automobile.

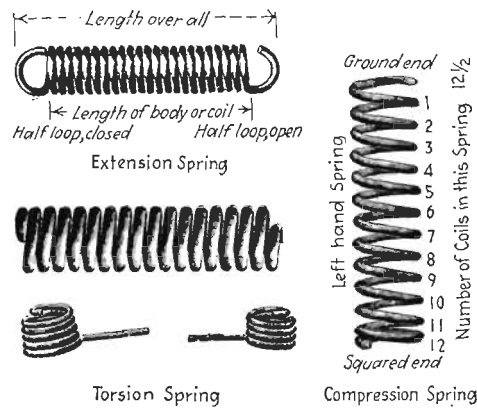


FIG. 68.—Springs.

The lag screw (Fig. 64) has a head like a machine bolt, while the other end is sharp. The threads are coarse and similar to an ordinary wood screw. It is used to attach machinery to floors or beams. The coarse

threads, when started, will draw themselves into the wood as the screw is turned with a wrench.

Wood screws, unlike the lag screws, are rather small and have slots across the head so that a screw driver can be used to force them into the wood.

73. Washers.—Different kinds of washers are used extensively in connection with bolts in farm machinery. They may be used on either the end beneath the head of the bolt or beneath the nut. Washers are of various kinds as follows: flat malleable-iron, cast-iron, wrought-iron, and spring-lock washers. There is very little difference between malleable- and cast-iron washers, both being rather thick, oftentimes $\frac{1}{2}$ inch, and are placed where there is a considerable amount of wear. Wrought-iron washers are round disks with holes in the center to allow their being placed under the nut. Lock washers (Fig. 67) are made of spring steel with one side split from edge to center of the hole. The ends of split parts are turned in such a manner that they will allow a nut to be turned down easily, but resist any effort to turn it off.

74. Springs.—Springs (Fig. 68) play an important part in the operation of farm machinery. Extension springs aid in lifting and adjusting heavy implements. Compression and torsion springs facilitate the operation of certain parts of a machine.

CHAPTER VI

SELECTION OF FARM MACHINERY

Before taking up the general discussion of the various individual farm implements and their construction features, it is well to stop and consider some important items that apply to all implements in general. These points or qualities that a machine may have or lack are abstract in a way yet fundamental in their bearing on the quality of the machine. They are factors that will enable the student to judge a machine better; they will call to his attention the points to look for which may have an important bearing in selecting one machine over that of another.

75. Trade Mark.—The standard definition of a trade mark is given as follows: Trade mark is a distinguishing mark, device, or symbol fixed by a manufacturer, merchant, or trader to his goods in order to identify them as his goods, and to distinguish them from the goods manufactured, sold, or dealt in by others. Such a mark or symbol is the exclusive right of the user when recognized by law. Most countries give special statutory protection to such trade marks as are registered according to law. The essence of a trade mark is that it distinguishes the owner's goods from those of another.

The trade mark is of importance in the selection of farm machinery because of what it stands for. Manufacturers spend many years and much money in building a reputation and getting the trade mark on their goods to mean something. After they have their reputation and trade mark thoroughly established and well known among the trading world, they will continue to try to maintain it. It is not always possible to judge a machine by its appearance and to determine whether good materials are used in its construction. It is impossible to tell whether a piece of material is good or whether it is bad by simply looking at it, especially after it has been painted. Therefore, if it has a trade mark backed by a firm that has a good reputation, the manufacturer of such implement is behind that particular piece of machinery. If any defect occurs within a reasonable length of time, the firm will make it good. In other words, then, we may say that the trade mark of a machine is a guarantee of what lies beneath the paint. Look well to the builder of your machine when you are judging and preparing to invest.

76. Trade Name.—The trade name is the name by which an article is called among dealers, or we may say it is a name given by a manufacturer or merchant to an article to distinguish it as one produced and

sold by him. It is an entirely different name from that of the trade mark. If the trade mark consists of a name, for example, "Avery" and a machine be stamped with the name, then on the same machine another name is found, such as "Champion," "Bob Cat," or "Oriole;" the word "Avery" will be found on all implements made by that company but "Champion," "Bob Cat," and "Oriole" will be found only on one particular class, such as mowers or plows. What is true of the trade mark, with reference to its becoming well known, is also true of the trade name. Practically every machine made by standard manufacturing companies has a trade name to go along with the trade mark. It is the aim of the manufacturer to get the name so well known among the users of such implements that it may be on the tongue of everyone.

77. Repairs.—Before considering the purchase of any machine, it is well to look into the source of repairs. Can repairs be secured near at hand or will it be necessary to send several hundred miles away to secure them? No farm implement has yet reached the stage of perfection where it will not break, wear out, or meet with accidents; therefore, it will need repairs. Many times the saving of a crop depends upon the quickness with which repairs can be secured. If breakdowns occur in the midst of plowing, planting, or harvesting, these breakdowns may cause so much delay that the crops will be lost. The larger implement companies maintain repair supplies at many points in order that they may render quick service to every part of the country. The machine should be examined to see whether it is accessible for making repairs when needed. Provision should be made in all implements for taking up the wear of bearings and gears. Look well to the source of supplies before buying a machine.

In making up the order for repairs that are needed, be sure to secure the following information:

1. The name and address of the manufacturer.
2. Trade name, model number, year made or purchased.
3. Number of the part wanted.
4. If the number of the part cannot be determined, then get the numbers of the parts with which it works.

78. Design.—Design is the arrangement of the parts to show the difference of makeup in machines of the same type. Manufacturers may put out the same line of implements but they will not be exactly alike. It is this difference of the arrangement of the elements that make up the design of the machine. In studying the general construction of the machine, keep in mind the number of castings, gears, and points of wear. The simpler the machine the better it is from the standpoint of design. Avoid machinery that is complicated. The fewer parts there are to wear or take care of, the better it will be for the average farming man. The machine should be designed to give sufficient strength. Points to keep

in mind while judging a machine are: Does it look substantial enough? Will it do the work required of it? Is it practical? If there is any doubt, it is best to buy the machine upon the condition that it will do the work planned. Such conditions should be put in writing.

79. Workmanship.—Machines for the farm should be well built and finished. Many makes of machinery may be of good design yet finished so roughly that they indicate poor workmanship. The time is past when anything will do for the farmer, for today he is needing and using machinery that calls for just as much inventive genius to develop and mechanical skill to manufacture as the machines used in most of the trades or professions. Farm implements should be judged on their workmanship. Such things as the snug fitting of bolts, gears, bearings, and means of lubrication should be considered. See if the nuts are provided with lock washers, or some other means to prevent losing. All oil holes should be provided with covers to prevent grit and dirt getting down into the bearings. In general, does the machine have a finished look or does it look rough and unfinished?

80. Ease of Operation.—Many implements look well but when they are used it is found that they require an unnecessary amount of power and labor to make them operate successfully. Of course, it is not always feasible to have the machine demonstrated to see if it will operate easily; nevertheless, such things should be considered in the selection of the machine. The ease of operation may simply depend upon the correct adjustment. It is not an uncommon thing for a farmer to purchase an implement, take it home and after attempting to use it, condemn the machine because of its hard operation. He may go so far as to take it back to the dealer and ask for his money back. If the dealer is a good one, he will usually take the machine out, have the farmer go along, make the necessary adjustments and see that the machine is running perfectly before he turns it over to the farmer.

81. Adaptability to Work and Conditions.—There are many implements on the market which are not adaptable to every condition. A machine may work in one locality and be an absolute failure in another because it is adapted to one and not the other. This may be due to soil conditions or to the type of crop grown. To take an example: Tools built for the Southeastern and Gulf Coast states are not suitable for use in the Southwestern states, New Mexico or Arizona, because of the difference in climate which influences the methods of preparing the seed bed, of planting, and of cultivating. Heretofore, the manufacturer has been depended upon to send the right implement to the right locality, but the people in these localities should look out for themselves because there are some manufacturers that are unscrupulous enough to sell anything they can.

82. New Devices.—If one will take the trouble to look into the farm-implement trade journals, he will be surprised at the many new devices that are being patented from time to time. The majority of these new inventions have not been tried out, but are simply the idea of some man who thinks he has a money-making proposition. About ninety-nine out of every hundred will never be heard of again. It is a very good plan to follow the instruction of Benjamin Franklin, who said, "Never be the first to try the new, but never be the last to give up the old." In other words, the idea is to let someone else try out the machine first and see how it works and how it stands up or at least have it thoroughly demonstrated. If the machine proves to be a good one, adaptable to local conditions, economical, and a labor-saving device, then do not hesitate to invest.

83. Where to Buy and Why.—Many people do not well consider where they should purchase a machine. There are five possible places:

1. The factory.
2. The branch house of the factory.
3. The local dealer representing the branch house.
4. The jobber.
5. The mail-order house.

The question is, from which of these five places would it be best to purchase a machine? If purchased from the factory, will the price be any better than if purchased from the home-town dealer? Most factories are located close to the source of fuel supply and construction material, such as iron. The result has been that most of the factories are located around the Great Lakes. If a man living in Texas wanted to see the machine before purchasing it, he would have to pay railroad fare to and from the factory, which would add materially to the cost of the machine. There are one or two small implement concerns, however, within the borders of that state. After the man has reached the factory could he get better prices than if he went to his local dealer? In practically every case he will not. In fact, most factories would refuse to sell him and refer him to his local dealer.

All factories that are of any size will have branch houses. The others that are not large enough to maintain branch houses will place their machinery in the hands of jobbers. Branch houses are usually located at a distributing point which will best serve their district. This place may still be quite a distance from the buyer. The same thing is true in going to the branch house as when the man went to the factory. He would not get any better price than he would get from the local dealer. In addition, the freight charges would be greater because of small shipment.

The smaller manufacturers cannot establish and maintain branches and, consequently, must place their goods in the hands of a jobber

or middleman who sells them to dealers, who, in turn, sells to the farmer.

The best place to purchase farm equipment is from the local dealer who handles a line of farm implements of a reliable manufacturing concern. He buys in large quantities usually car-load lots, thus getting a low freight rate. This dealer will give as good a price as can be secured at the factory or branch house. If he is a good dealer he will have an established place of business and carry a supply of implements together with repairs for same. He will also know enough about the line to give beneficial service in the way of setting up and servicing the machine, seeing that it will operate satisfactorily, and maintaining a local source of repair supplies which will aid materially in avoiding delays.

How about buying machinery from the mail-order house? Such houses do not handle what is called a *standard line* of machinery. The catalogue prices may be slightly under those quoted by the home dealer, but there is the delay of waiting for the goods, as well as buying something that has not been seen. If the machine should get out of order, break, and need repairs, there is no supply closer than the mail-order house. The average dealer will not consider supplying repairs for such implements; therefore, the owner of the machine will have to order his own repairs. Much delay, of course, will be involved.

Considering all factors, the best place for the average farmer to purchase machinery is from the local dealer. He sells a standard line of implements, as a rule he maintains a supply of repair parts. He is in a position to give service, advice, and demonstrations if desired.

Other factors to consider in addition to the foregoing are:

Need of the machine, cost of the machine, cost of operation, cost of repair, power required to operate the machine, and years of service to be expected.

PART III

SOIL PREPARATION MACHINERY

CHAPTER VII

THE PLOW BOTTOM AND ITS PARTS

84. Influence of the Plow on Man.—When man took a crooked stick and began to till the soil he made his first step toward civilization. With each step in the development of the plow, there has been a corresponding advancement in civilization. In the beginning one man, even though he gave all his time and energy to the task, could till only a small acreage. Later, animal power was applied and the acreage per man was increased. Now, with the large amount of mechanical power available, the acreage per man has been very materially increased. Thus, man can now produce more foodstuff than is necessary for his own sustenance and furnish food to many who are working at other tasks. Hence, we can say that the plow is the foundation of civilization. In the production of all kinds of crops and in the preparation of a seed bed for them, the plow is the first tool used and it is, thus, the basic tool of the farm. With the plow the ground is broken and pulverized into small particles, lifted, turned over, and all trash on the surface completely covered. One not familiar with the nature of the soil, the influence of water, air, and temperature upon its physical condition, and the action of the plow upon it, may think that the plow is a very simple tool. But those who are familiar with the soil conditions and the plow adjustments necessary to obtain the best results know that the plow is the most important and complete tool on the farm, requiring the consideration of more factors for the proper adjustment than does a gas engine. Usually, it is thought to require very little adjustment and practically no care at all.

85. Objects of Plowing.—In the preparation of the seed bed it is necessary to keep in mind some of the benefits to be derived from such an operation. With the plow we strive to accomplish the following results:

1. To obtain a deep seed bed of good texture.
2. To create a mellow soil for the seed.
3. To add more humus and fertility to the soil, by covering vegetation and manure.
4. To destroy and prevent weeds.

5. To leave the soil in such condition that air will circulate freely.
6. To leave the soil in such condition as to retain moisture from rain.
7. To destroy insects as well as their eggs, larvae, and breeding places.

86. The Plow Bottom.—The real unit or base of the plow is called the *bottom*, which is composed of those parts necessary for the rigid structure to lift, turn, and invert the soil. These parts which form a three-sided wedge are: the frog, share, landside, moldboard, and brace to give rigidity to the assembled parts. Looking at the landside of the plow the parts that cut and lift the furrow slice are in view. Viewed from above, the shape

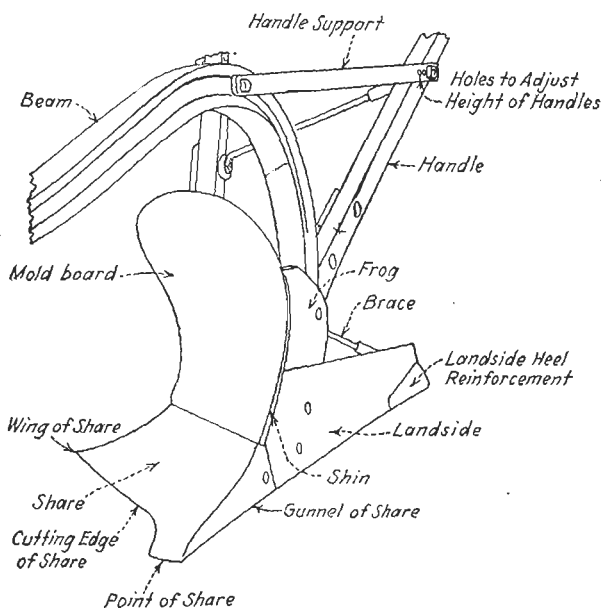


FIG. 69.—The various parts of a walking plow.

of the bottom is such as to cause the furrow slice to be moved to one side. This is accomplished by the upper part of the share and the moldboard.

87. The Frog.—Figure 69 shows the frog which is the foundation of any plow bottom. It is an irregularly shaped piece of metal to which the share, landside, and moldboard are attached. Take the frog away and all other parts are useless because they cannot be held in their proper positions. In most plows the beam is also attached to the frog (Fig. 69).

Frogs are generally made of steel, malleable iron, or cast iron.

Steel is used more extensively than any other material for making frogs. It is a light, strong, durable, and easily shaped material.

The malleable-iron frog is used on plows that do not require the frog to be made thin and small.

If the frog is not very large, it is often necessary to reinforce it to prevent bending or breaking. Should the frog of any plow become bent, it is almost impossible to bring it back to the original shape.

The cast-iron frog is used only on the cheaper plows of the one-horse type having a wooden beam. In such plows the frog and standard are made in one piece.

88. The Share.—The share (Fig. 70) provides the cutting edge for the plow. The principal parts of the share are the point, the wing, and the

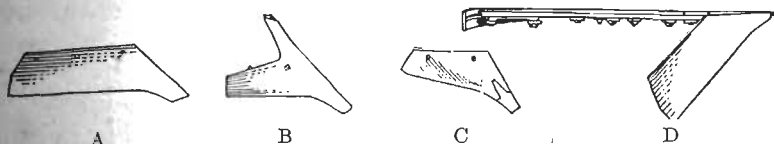


FIG. 70.—Kinds of shares: A, slip share; B, shin share; C, slip-nose share; D, bar share.

cutting edge or throat. The point is the first part of the plow to penetrate the soil. The wing is the outside corner of the cutting edge (Fig. 69). The cutting edge extends from the point to the wing. This edge is curved and forms the throat of the share.

The four kinds of shares are slip, shin, bar, and the slip nose (Fig. 70). The slip share has no extension to form the landside as does the bar share. The shin share has an extension to form the cutting edge or shin for the moldboard. When a share is replaced with a new edge, the cutting edge and the shin are new. The slip-nose share is one where the point is detachable. The materials used in making shares are plain crucible steel, soft-center steel, chilled cast iron, and cast iron.

Figure 71 shows shares having three degrees of suction: regular suck, deep suck, and double-deep suck. The amount of suction is around $\frac{3}{16}$, $\frac{5}{16}$, and $\frac{3}{8}$ inch, respectively. Walking plows are regularly equipped with regular suck shares. Wheel plows, both horse and tractor drawn, are equipped with the deep suck.



FIG. 71.—Share suction: 1, regular suck— $\frac{3}{16}$ inch for light soil easy of penetration; 2, deep suck— $\frac{5}{16}$ inch for ordinary soil that is dry and hard; 3, double-deep suck— $\frac{3}{8}$ inch for stiff clay soils, gravel land, and other soils where penetration is difficult.

89. Cast-iron Shares.—The cast-iron shares are made for the cheap walking plow and are very easily broken. The plow must be handled carefully at all times. A sharp blow or a shock will break the share which must then be replaced with a new one. They cannot be welded by the ordinary blacksmith. Very little care is taken in the manufacture of cast-iron shares which results in non-uniformity and poor fitting.

90. Chilled Cast-iron Shares.—Chilled shares do not rust easily and do not wear so rapidly as the cast-iron or steel ones. They are especially

adapted to sandy and gravel soils but work well in a clay or loam soil.

91. The Plain Steel Share.—This share is made of steel that is of the same structure throughout. The land face or gunnel is welded onto the share proper by a lap weld.

92. Soft-center Steel Shares.—The soft-center steel shares are being used extensively on steel plows and for soils that do not scour well.

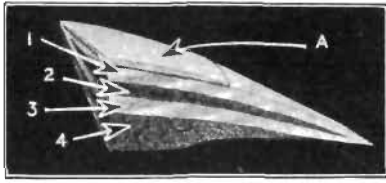


FIG. 72.—Soft-centered steel share point (landside toward figures): A, patch of hard steel for reinforcement. 1 and 3, hard steel; 2, soft steel; 4, steel landside, lap weld.

The very hard surface takes a good polish and consequently will scour where other metals will not. However, they are more expensive than any of the other types. Since soft-center steel shares have been placed on the market the many attempts at imitation can be easily detected by the method described under soft-center steel. Many shares are reinforced by having an

extra patch welded on the upper side of the point (Fig. 72).

93. Sharpening Soft-center Steel Shares.—When sharpening soft-center steel shares special care must be taken because of the peculiar way in which they wear. Strange to say, the under side wears away faster than the upper.

Heat only to a cherry red or 1470° F. The shares should be placed in the forge flat and not vertically (Fig. 73). If placed vertically, heating cannot be confined to the edge. When heating extends the greater part

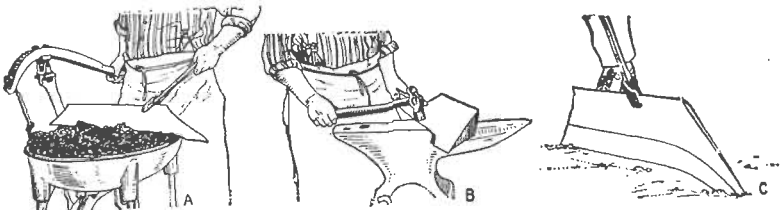


FIG. 73.—Steps in the sharpening of a plow share: A, only the part of the share to be pounded out should be heated; B, hammer on the top side; C, the right way to place a plowshare for cooling.

of the way back across the share, warping will likely occur. Heat only a small portion at one time and begin at the point, working back to the wing. Hammering should be done only on the upper side with the lower side flat on the anvil (Fig. 73). This is necessary because the thicker layer of hard steel can be drawn out over the soft steel in the center and the thin layer of hard steel on the under side. If the hammering is done from the under side, the soft center will be left exposed and very likely the top layer will be loosened and parts flake off. Care should be taken not to destroy suction in the share.

94. Sharpening Crucible-steel Shares.—Even though they are solid throughout, crucible-steel shares are best sharpened in the same manner as soft-centered steel-shares. They can be hammered on the under side, however, but in doing so there is more danger of disturbing the set.

95. Sharpening Chilled and Cast-iron Shares.—This material cannot be heated and hammered to draw out the edge because of the brittleness

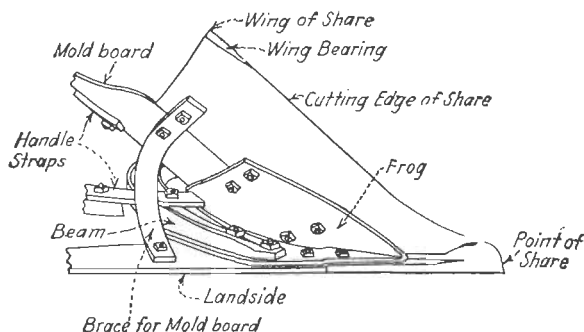


FIG. 74.—The under side of a plow bottom.

of the material. Instead of being hammered they must be ground and this should be done on the upper side. A safe rule to follow in sharpening any share, whether it be soft-center or crucible steel, chilled or cast iron, is to work from the upper side.

96. Repointing Shares.—Shares that are badly worn or have been sharpened a number of times should be repointed by welding a 6-inch piece of steel bent U-shaped to both the lower and upper sides of the point.

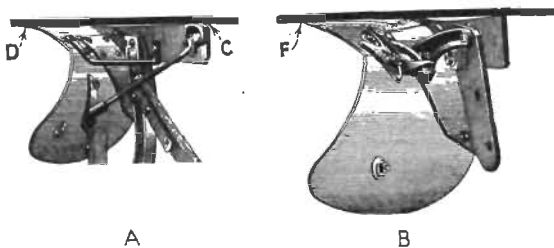


FIG. 75.—Wing bearing. *A* shows the wing bearing on a walking plow, and *B* shows the small amount required for a wheel plow. To measure the wing bearing *AD*, place the straightedge across the heel of landside at *C* and wing of share at *D*. The wing bearing is the amount in contact with the straightedge at *D*.

97. Treating the Cutting Edge of Shares.—Steel shares can be used much longer without sharpening by applying a hard metal, like Stellite, to the cutting edge with a welding torch. Care should be taken to get the hard metal well distributed on the bottom side of the cutting edge.

98. Points of Bearing.—There are three points of bearing on an ordinary walking plow, namely, the point of the share, the wing of the share,

and the heel of the landside. These three points are the only points that actually come in contact with the furrow sole, as can readily be seen as the plow rests on the floor. The curvature from the point of the share to the heel of the landside makes the "vertical suction."

The amount of "bearing at the wing" (Fig. 74) will greatly influence the operation of large walking plows. Plows mounted on wheels do not

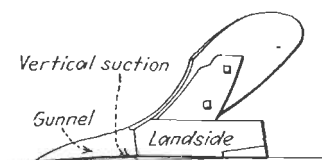


FIG. 76.—On a walking plow the amount of vertical suction should be measured at the intersection of share and landside.

require wing bearing, as they are controlled by the lead of the furrow wheels. The amount will vary from almost nothing to $1\frac{1}{2}$ inches according to the size of the plow and soil conditions. The wing bearing for a 12-inch walking plow is about $\frac{3}{4}$ inch, a 14-inch plow $1\frac{1}{4}$ inches, and for a 16-inch plow $1\frac{1}{2}$ inches. The amount of wing bearing is measured as shown in Fig. 75.

It is the amount of the share that is in contact with the straightedge at *D*. The effect of wing bearings will be discussed under Troubles.

99. Vertical or Down Suction.—This is the bend downward of the point of the share to make the plow penetrate the soil to the proper depth when the plow is pulled forward. The amount of suction will vary from $\frac{1}{8}$ to $\frac{3}{16}$ inch depending on the style of the plow and the soil it was made to work in. This suction can be measured on a walking plow by placing

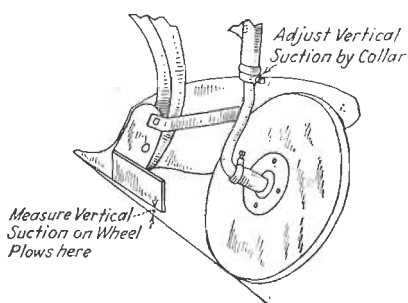


FIG. 77.—Illustrating how the vertical or down suction should be measured and adjusted on a wheel plow.

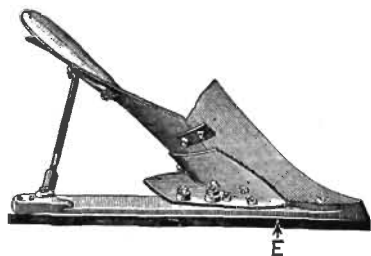


FIG. 78.—Position of straightedge to measure the horizontal or land suction at *E*.

a straightedge on the bottom of the plow extending from the heel of the landside to the point of the share, then measuring vertically the greatest distance from the straightedge to the plow bottom (Fig. 76).

On all moldboard plows mounted on wheels, it will be noticed that the heel of the landside does not touch the floor when properly set; the vertical suction in this case will be the amount the heel of the landside is elevated above the floor (Fig. 77). Ordinarily this is about $\frac{1}{2}$ inch with the average length landside.

Slat moldboards (Fig. 81) are those that have sections cut out lengthwise of the moldboard leaving only about half of the surface to come in contact with the furrow slice. These are sometimes used where soils will not scour. It is claimed by some to give a more thorough soil pulverization.

The rod type of moldboard (Fig. 81) consists of round rods attached to the plow in such a manner as to form a surface upon which the furrow

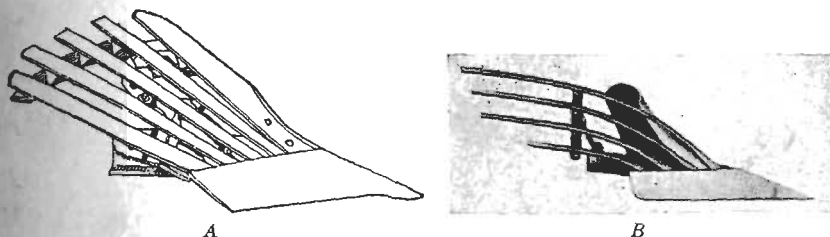


FIG. 81.—Special types of plow bottoms: A, slat moldboard; B, rod moldboard.

slice will be turned. There will be little, if any, pulverizing of the soil with this type of board. It is found to be practical and useful in some soils of the prairie type that are sticky and will not shed as they should from solid molds.

Generally, there are three materials used in the manufacture of moldboards; namely, the soft-center steel, crucible steel, chilled cast

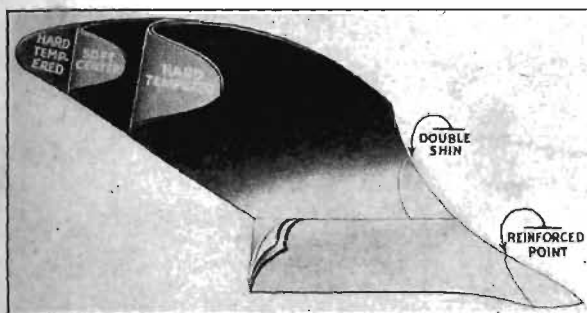


FIG. 82.—Plow bottom showing soft-centered moldboard and share and method of reinforcing point of share and shin of moldboard.

iron, and, on some of the very cheap plows, cast iron. Soft-center steel moldboards, as shown in Fig. 82, are the best to use under most conditions. This is because the majority of soils will scour better on this type of material. For the Middle West the steel plow seems to give satisfaction in most cases. Because of their wear resistance qualities due to the hardness of the material of which they are made, chilled plows are better for the sandy, gritty, and gravel soils. Chilled plows are adaptable to all parts of the South where there is sandy land and especially in the yellow pine districts.

The *shin* (Fig. 82) is the cutting edge of the moldboard, just above the landside. Detachable shins, as shown in Fig. 83, are not used extensively, however, they would be very desirable on stony and gravel soils where wear is excessive.

On some moldboards an extension is provided to turn the soil over more gradually and completely.

104. Size of the Plow.—The size of a moldboard plow is its width in inches. This is determined by measuring the distance from the wing to

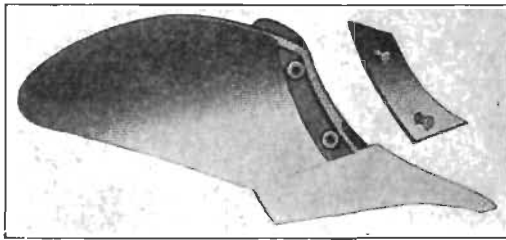


FIG. 83.—Detachable shin.

the landside. The rule is held perpendicular to the landside. Walking-plow sizes are 6, 7, 8, 9, 10, 12, and 14 inches, but wheel horse-drawn and tractor plow sizes are 10, 12, 14, and 16 inches. Special brush plows may be as large as 18 and 20 inches.

105. The Furrow.—The *furrow* may be defined as the opening left in the soil after the furrow slice has been removed by the plow bottom (Fig. 84). The *furrow slice* is the soil that was cut, raised, and inverted by the share and moldboard. The *crown* or bank is the upper surface

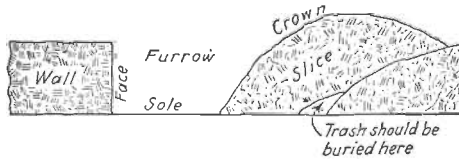
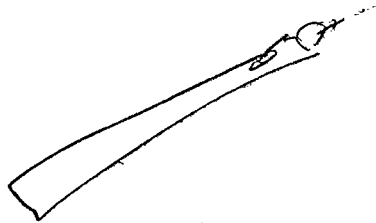


FIG. 84.—The various parts of a furrow.

of the furrow slice after being inverted. The *sole* is the bottom of the furrow on which the plow bottom slides. The *furrow wall* is the unplowed land. The *face of the furrow wall* is the smooth vertical face left by the landside.

A *dead furrow* is the trench left in the field after a "land" has been plowed. This trench is slightly wider than twice the width of the plow bottom used. It should not be left open but filled by making a round trip across the field throwing furrows into the trench.

A *back furrow* is the ridge left across the field where a land is started. On the return trip across the field the furrows are lapped on top of those made the first time across the field.



CHAPTER VIII

PLOW ACCESSORIES

The plow bottom and its parts are the real working parts of any plow. All parts other than the bottom can be considered as accessories. They, however, are necessary to obtain good work. For the walking plow, the handles, beam, and clevis are the principal accessories. Some form of coulter, weed hook, and gage wheel may be used when needed. Other types of plows may have, in addition, harrow attachments, levers, wheels, and a frame upon which the bottoms are mounted.

106. Handles—are necessary on the walking plow no matter how well it may be adjusted. A certain amount of guiding is necessary while

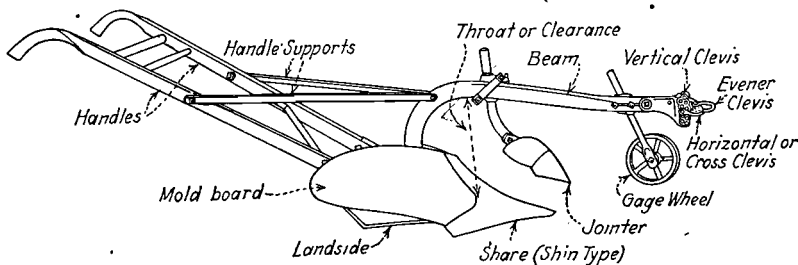


FIG. 85.—A walking plow equipped with jointer and gage wheel.

the plow is in operation, even though it is said that it should operate without guiding when properly adjusted. Handles are also used to lift the plow around at the ends of the furrow. Because of its lightness wood is ordinarily used for plow handles. When steel is used, wooden grips are often provided. On the standard walking plow, iron straps are used to fasten the lower ends of the handles to the moldboard and frog or landside; other straps from the beam to the handles support them (Fig. 85). These straps usually have several holes at the ends to allow the handles to be raised or lowered to suit the height of the operator.

107. Beams.—The beam (Fig. 85) is attached to the plow bottom and extends out to the front to form a suitable means for the team or tractor to draw the plow forward. It may be either steel or wood.

Wooden beams are used only on the very cheap plows of the walking type or upon the heavy road type where there is danger of hanging the plow bottom upon a root or stump and springing or breaking the beam. On wooden beam plows provision is made to take more or less land by an adjustment at the rear of the beam on the standard.

The ordinary cheap walking plow that has a wooden beam will also have a cast-iron frog.

The steel beam is curved in such a manner that it is fastened behind the moldboard, being attached to either the frog or the landside. It is also curved so that there will be sufficient clearance at the throat of the plow to give ample room for the handling of the furrow slice as well as trash. The end of the beam to which the clevis is attached curves downward so that it will be in alignment with the center of resistance of the plow bottom and the point at which the plow is attached to the power. Steel beams are made of high-carbon steel and will stand considerable strain without bending. When bent they are very difficult to reshape to their original curvature and it is better that a new beam

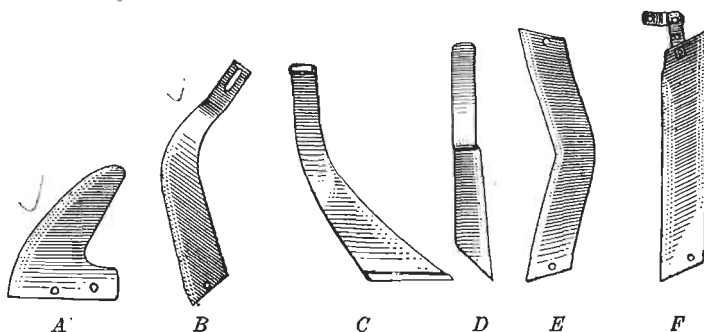


FIG. 86.—Types of knife coulters: A, fin; B, knee cutter; C, standing cutter; D, hanging cutter; E, Quincy cutter; F, reversible cutter.

be obtained. Some steel beams have a special device for landing them at the rear in the same manner as that of the wooden beam.

108. The Clevis.—The clevis (Fig. 85) is a special arrangement at the end of the beam to form a connection with it and that of the eveners. Provision is made for both horizontal and vertical adjustments. This is necessary in order to get the proper adjustment to bring the center of power and the center of load as near together as possible. It also provides an adjustment for depth and width of furrow.

109. Coulters and Jointers.—Coulters are special attachments placed on plows to cut the furrow slice loose from the furrow wall instead of allowing the shin of the plow to tear its way through the soil. There are many types of coulters named according to their shape and manner of attachment to the plow. Coulters are classified as sliding and rolling. Sliding coulters can be classed under two general heads: knife and fin.

Included under the knife coulters are all the hanging coulters, knee cutters, and reversible coulters, sometimes called *double enders*. Types of these are shown in Fig. 86. The hanging coulters are always attached to the beam and allowed to hang underneath, going deep enough into

the soil to cut the furrow slice loose. The double enders and the knee types may be attached both to the beam and to the share.

The *fin coulter* (A Fig. 86) is an irregular-shaped piece of steel which is bolted to the land face or gunnel of the share and extends upward to cut loose the furrow slice. It is used principally in sod land.

The *rolling coulter* (Fig. 87) is a round, flat, steel disk which has been sharpened on the edge and suspended on a shank and yoke from the beam. It is so constructed that it can be adjusted up and down for depth and sideways for width of cut. This type of coulter is used more than any of the others. The rolling coulter will leave a smooth furrow face and will also cut trash much better than the other types.

The *jointer* is a small irregular-shaped piece of metal having a shape similar to an ordinary plow bottom (Figs. 85 and 88). It is a miniature plow. Its purpose is to turn over a small ribbon-like furrow slice, directly in front of the main plow bottom. This small furrow slice is cut from the upper side of the furrow slice and is inverted. All trash that has been on top of the soil is completely turned under and buried in the right-hand corner of the furrow. The United States Department of Agriculture has recently developed a swivel or self-aligning disk jointer that swings to one side when an obstruction is encountered and automatically swings back after it has been passed over (Fig. 89).

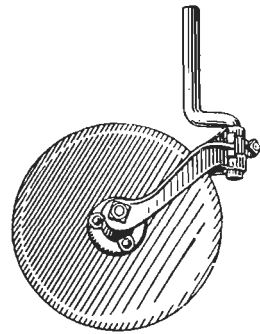


FIG. 87.—Rolling coulter.

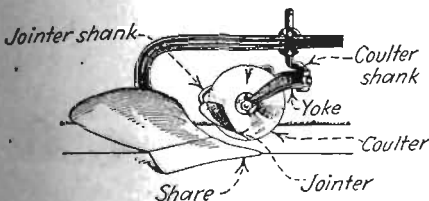


FIG. 88.—Combination rolling coulter and jointer showing how the hub of the coulter is set over the point of the share.

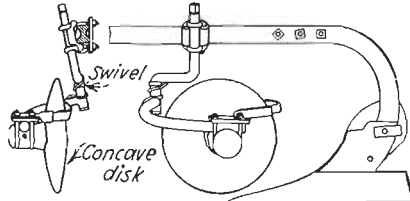


FIG. 89.—Swivel disk jointer. (U. S. Department of Agriculture.)

The jointer is used not only by itself but also in combination with the rolling coulter (Fig. 88). This gives a *combination rolling coulter and jointer*. The rolling coulter cuts the main furrow slice and all trash vertically from the furrow wall, and the jointer turns its miniature furrow slice as when working alone. The advantage of the combination rolling coulter and jointer is that the rolling coulter cuts all trash and allows the jointer to turn its furrow slice without any trash hanging around the shank.



110. Setting Coulters.—There are three essentials to consider in setting any type of coulters: first, the depth at which the best work is done under average conditions. This will depend on the depth of plowing, vegetable matter on surface, and the physical condition of the soil.

To cut trash thoroughly the rolling coulters should make with the surface of the ground a shear cut, using the ground as one edge of the shear. That, of course, depending upon size, limits the depth the rolling coulters

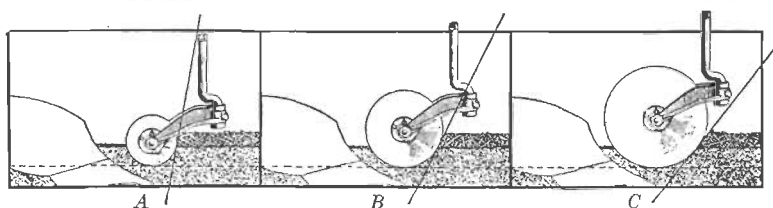


FIG. 90.—The size of rolling coulters influences their ability to mount and cut trash. In A and B the coulters are too small to mount the trash if it is set deep enough to properly cut the furrow slice. C shows the correct setting for size of coulters.

is set, as shown in Fig. 90. Large rolling coulters are more effective under trashy conditions as they will mount trash better than small coulters. Notched- or scalloped-edged rolling coulters cut heavy trash better than smooth-edged coulters.

Under average conditions the rolling coulters should be set deep enough to cut trash without clogging and shallow enough to cut trash without riding over part of it. A good rule with large plows is to have the diam-

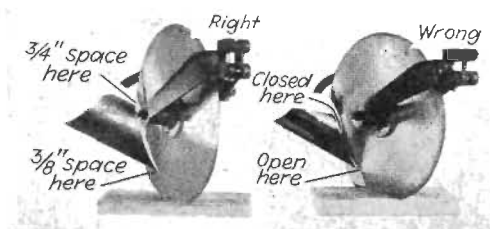


FIG. 91.—Right and wrong way to adjust combination rolling coulters and jointer. (*Ind. Agr. Expt. Sta. Cir. 217.*)

eter of the coulters equal to the size of the plow bottom with which it is used. If there are stones, tree roots, or stumps, the coulters should be set ahead of the share point and deep enough to prevent the point of the share from hanging under obstructions.

The second point to consider is the horizontal position of the coulters to the shin of the plow. To make the furrow face smooth, the coulters must be set to the left of the shin and deep enough to prevent the shin from digging into the furrow wall. For average conditions, about $\frac{1}{2}$ to $\frac{5}{8}$ inch to the left of the shin will be sufficient (Fig. 92) but no set rule can be given.

The third essential is the longitudinal relation of the position of the coulter to the point of the share. For the average plowing job, the rolling coulter should be set so that the center or hub of the coulter will be almost directly above the point of the plow (Fig. 90). If the ground is hard, the coulter should be set high and back of the plow point; otherwise it will affect the penetration of the plow.

If hanging knife coulters are used they should, for most conditions, be set with the points about 1 inch above the point of the share and the whole cutter slanted backward. Where the jointer is used with the rolling coulter, the former is set so that the heel, which corresponds to the wing of the plow, is just above the surface of the soil. The point of the jointer should fit close up to the side of the rolling coulter, but should not bind.

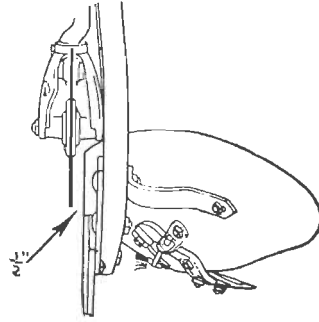


FIG. 92.—Horizontal adjustment for rolling coulter.

111. Harrow Attachments.—It is usually best to harrow the soil immediately after it has been plowed. For fall plowing, however, it is

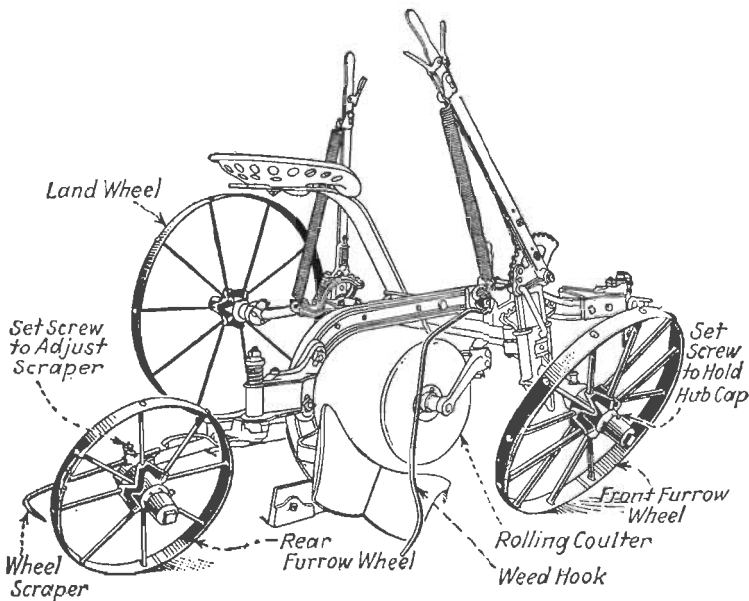


FIG. 93.—Low-lift (frameless) sulky plow equipped with rolling coulter and weed hook.

desirable to leave the soil rough to catch and hold snow and thus collect moisture. Leaving the soil rough will also aid in preventing wind erosion. Such attachments may be secured for this purpose composed of disk,

spike, knife, or propeller-like sections. These attachments are never used on the ordinary single-bottom walking plow but are generally used on the gang and engine plows. The attachments are placed to the right and rear of the plow and will completely harrow the soil as it is plowed.

112. Gage Wheels.—The average walking plow, when properly adjusted, is not supposed to need a gage wheel but on some of the larger plows it is of use to secure a more uniform depth and width of furrow. These wheels are attached at the end of the beam near the clevis (Fig. 85) and prevent the plow from penetrating deeper than it should go. They are adjustable. It is claimed by some to decrease the draft of the plow and to increase the life of the share. On engine gang plows they are used to prevent the plow from going too deep, especially in the soft sandy soils. In the multiple plows there may be one wheel for the whole plow or one or two for each bottom.



FIG. 94.—The Purdue plow trash shield. (*Ind. Agr. Expt. Station.*)

113. Weed Hooks.—The common type of weed hook consists of a rod attached to the beam and extending out to the front and side of the plow bottom (Fig. 93). The object of this is to bend the weeds over in such a manner that they will be completely buried in the bottom of the furrow. Good weed hooks may be made from an ordinary smooth wire attached to the beam or doubletree, and allowed to drag under the furrow slice. A small chain can also be used.

114. Trash Shields for Plows.—The trash shield (Fig. 94) is constructed of sheet metal shaped to form a hood over the top side of the furrow slice as it is turned over.¹ Trash can be buried deep enough so that it will not interfere with tillage operations. The trash is placed in the bottom of the furrow in the form of a roll, which covers from one-third to one-half of the width of the furrow. This leaves at least one-half of the width of the furrow practically free of trash so that capillary action of soil moisture is not materially affected.

¹ *Ind. Agr. Expt. Sta. Cir.* 217, 1936.

CHAPTER IX

MOLDBOARD-PLOW TYPES

In the discussion of the plow types it is well to consider the different kinds of plows according to the manner in which they are constructed and operated, either walking or riding, drawn by a team or by mechanical power.

Plow types are divided into two classes: moldboard and disk.

WALKING PLOWS

115. The Ordinary Walking Plow.—The walking plow (Fig. 95) was the first type of plow developed to the extent that it was considered a

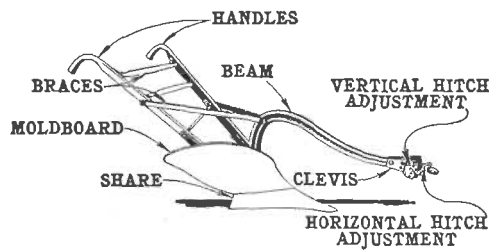


FIG. 95.—Common steel walking plow.

success. Many men worked upon the development of the walking plow but the steel plow was not developed until near the middle of the eighteenth century. The first successful walking steel plow was invented by John Lane, Sr., in 1833.

Walking plows are referred to according to the material in the bottom as steel, chilled and, in a few cases, cast iron. The various parts composing the walking plow, such as the share, moldboard, landside, frog, beam, handles, and clevis, already have been discussed. There may be right-handed or left-handed plows according to the direction in which they throw the furrow slice.

SPECIAL WALKING PLOWS

116. The New-ground Plow.—This plow (Fig. 96) is especially designed for ground that has been cleared of brush, leaving the soil well filled with roots. It is built with the idea of simply breaking the surface of the soil and, at the same time, cutting all roots. Its bottom is constructed with the share and moldboard in one piece. Wheels are

sometimes used to take the place of the landside. It also has a hanging coulter of the knife type to aid in cutting the roots. The beam may be made of either wood or steel. This size varies from 7 to 10 inches.

117. Reversible Hillside Plows.—Hillside plows (Fig. 97) consist of walking plows where the moldboard and share are hinged at the bottom

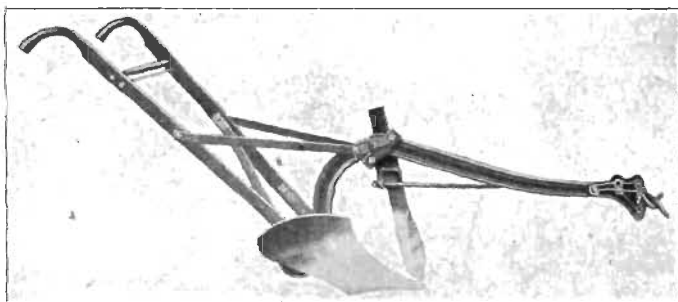


FIG. 96.—New-ground plow.

and can be reversed either to the right or to the left. The operator is enabled to make a right-handed plow into a left-handed plow by swinging the bottom underneath to the left. They are used in fields where all the furrow slices are to be thrown in the same direction, as on hillsides, from which they get their name. They are good plows for experimental

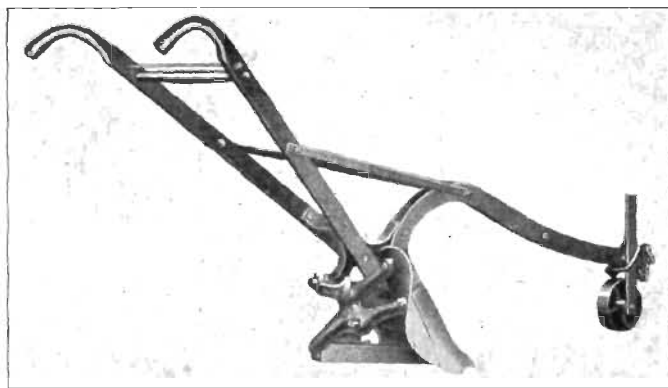


FIG. 97.—Walking hillside plow.

plots and irrigated fields. They are also good for plowing out irregular shaped fields and in corners. No dead furrow is left when this plow is used.

✓ **118. Subsoil Plows.**—In some parts of the country it is necessary to break the subsoil to aid in the retaining of moisture and to give a larger root zone for the plants. Such a plow (Fig. 98) is called a *subsoil* plow. Instead of having a share and moldboard as in the ordinary walking plow, these parts are almost entirely done away with. Extend-

ing downward from the beam is what is called the *standard*, which is made of steel. The front edge of this standard is sharpened, making a heavy knife. The shoe is attached to the bottom of the standard. This shoe is constructed somewhat on the order of a small share which has considerable vertical suction. The walking type of subsoil plow is used

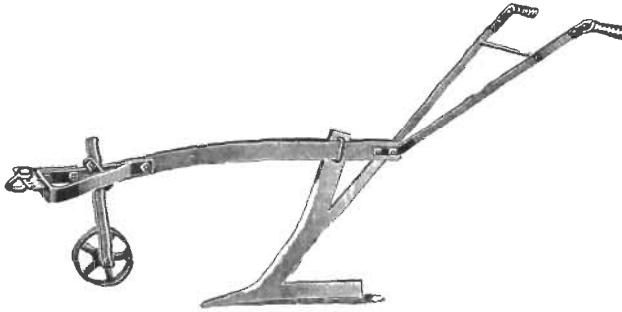


FIG. 98.—Walking subsoil plow.

in the bottom of the furrows behind the ordinary type of walking plow. This allows the subsoil plow to penetrate to a greater depth, loosening the subsoil beneath the furrow slice.

119. Middlebreaker.—This is a special type of walking plow which gets its name from the work it is required to do. In the South, where

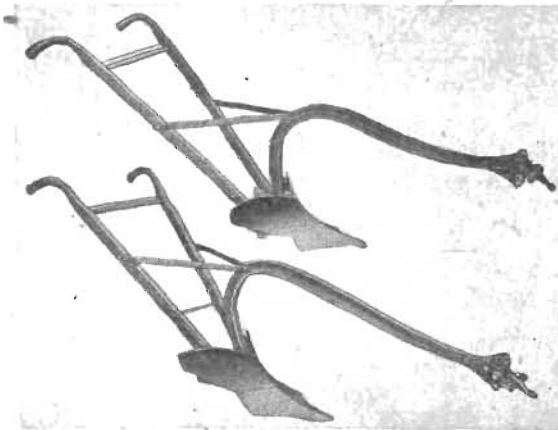


FIG. 99.—Walking middlebreakers. Above, sandy type; below, blackland type.

the middles in between the rows are burst out, it is called a *middlebreaker*. In the semi-arid sections of the country, where the crops are planted in the bottom of the furrow, it is called a *lister*. This same tool may be used in an irrigated country for opening up ditches. Here it is called a *ditcher*. However, it is more commonly known as a *middlebreaker*. It is constructed with two moldboards, one for turning the soil to the

right, the other for turning it to the left (Fig. 99). The share is a double-wing affair to take care of both the right and left boards. This plow, instead of having a landside, has what is called a *rudder*; it acts in about the same way as a landside on an ordinary walking plow. There is a knife or rudder blade attached to the bottom of the rudder which cuts down into the soil and prevents it from dodging to the side.

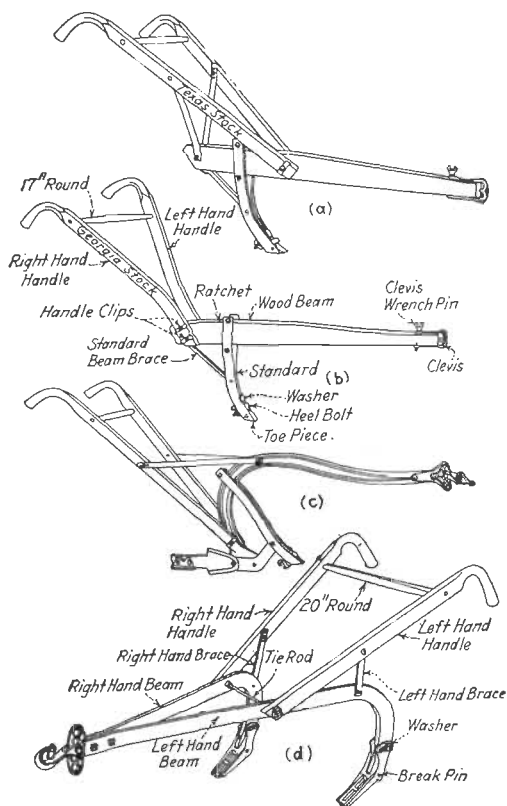


FIG. 100.—Types of plow stocks: (a) Texas stock; (b) Georgia stock; (c) sweep stock; (d) double shovel.

120. The Georgia Stock.—The Georgia stock ((b) Fig. 100) may be classed as a walking plow. This stock consists of a beam, handle, and a shank where the plow shape or shovel is attached. It is a one-horse, one-man outfit. A poor job of plowing is done with it and it is a very hard tool to adjust to do good work under the most favorable conditions.

121. Vineyard Plow.—The vineyard plow is a special built plow for working in vineyards, where it is necessary to plow close to the vines, yet, at the same time, prevent the handles from injuring the fruit and foliage. The handles on this plow are adjustable to the side to allow such work to be done.

RIDING PLOWS

122. Sulky Plows.—Horse-drawn plows upon which the operator rides are made with one or more bottoms. When it is made of one bottom it is called a *sulky* plow. When made of more than one bottom it is called a *gang* plow. The sulky plow may be classified as low lift and high lift. The first successful sulky riding plow was patented by S. F. Davenport in 1864.

The advantages of the sulky plow are: First, friction is reduced because the plow is mounted on wheels. Second, the operator is allowed to ride, affording greater ease of operation. Third, with the average unskilled plowman better work will be accomplished because it is steadier

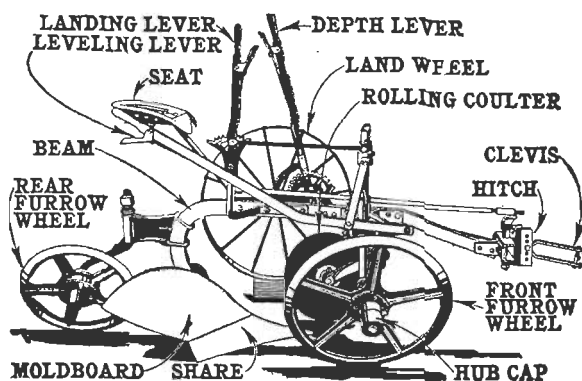


FIG. 101.—Low-lift (frameless) sulky plow.

and the adjustment cannot be easily disturbed. Fourth, there is a tendency to make the plow take the full width of the furrow at all times.

123. The Low-lift (Frameless) Sulky Plow.—The low-lift sulky plow, as shown in Fig. 101, may also be classed as a frameless and a tongueless plow, because there is no frame and no tongue. This plow is the first step after the walking plow. Really, it is a walking plow with the land wheel and the furrow wheels minus the handles. All three of the wheels are attached to the beam. With the low-lift sulky there is a lever on the front furrow wheel and one on the land wheel. These levers have a range of adjustment only sufficient to allow the bottom to be raised a short distance above the surface of the ground. The land wheel which runs on the unplowed land is a rather large light wheel running perpendicular while the front furrow wheel is inclined from the perpendicular. The rear furrow wheel is also slightly inclined from the perpendicular but not so much as the front furrow wheel. These are inclined to counteract the side pressure of the furrow slice as it moves backward over the moldboard. The low-lift sulky is quite popular

throughout the New England states and the Middle Eastern states. It is also being used extensively in the South and Southwest.

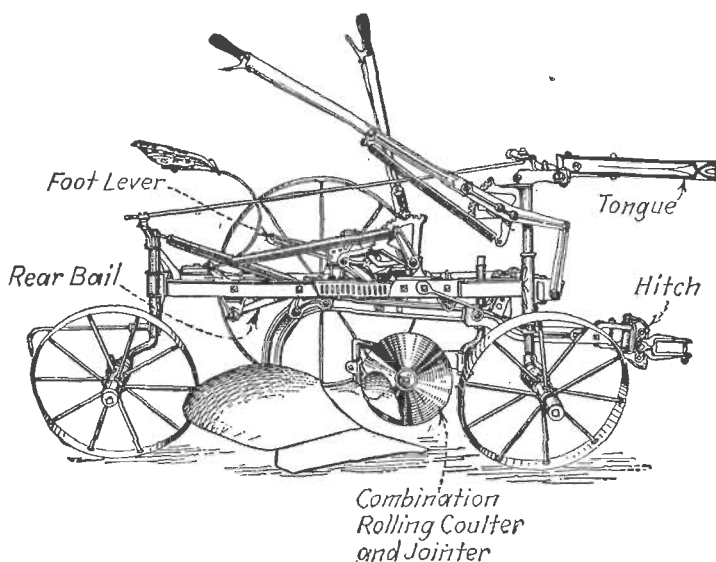


FIG. 102.—High-lift (frame) sulky plow.

124. High-lift (Framed) Sulky.—The high-lift or foot-lift sulky allows the bottom to be lifted higher than in the low lift. This plow has three wheels but instead of being attached to the beam, they are secured

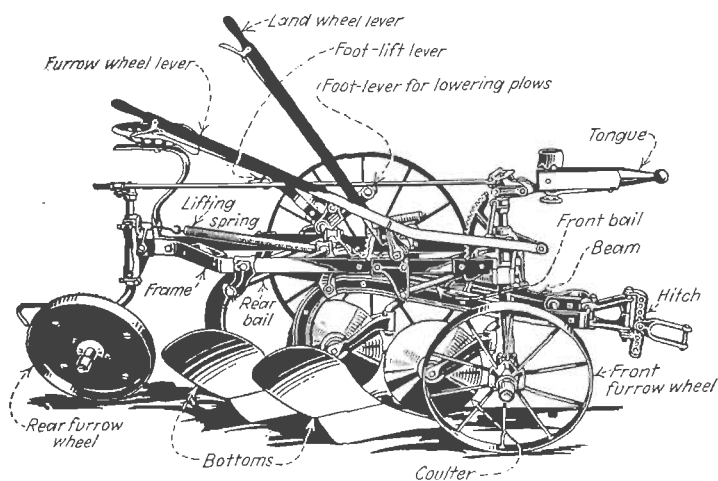


FIG. 103.—Side view of foot-lift on high-lift horse-drawn gang plow.

to the frame. The beam is suspended in the frame by means of bails (Fig. 102). The bails are U-shaped, the ends of which are fastened to the frame by means of the bail box. The beam is attached to the bottom of

the U and it is upon this that it is raised and lowered. By this arrangement the bottom can be raised several inches above the ground. Some plows are constructed with one bail and others with two. They are known as *single-* or *double-bail* plows. This style of plow can be made to float. This means that it will automatically come out of the ground if the bottom strikes an obstruction. When set to float, the bottom is not locked in the ground. When locked, should the bottom strike an obstruction, it will not come out of the ground as in the case where it is floating. The wheels of the plow are arranged and inclined in about the same manner as those of the low-lift sulky. The object of the tongue on this plow is to aid in guiding and in turning. The pole extends forward between the furrow horse and the one next on the land.

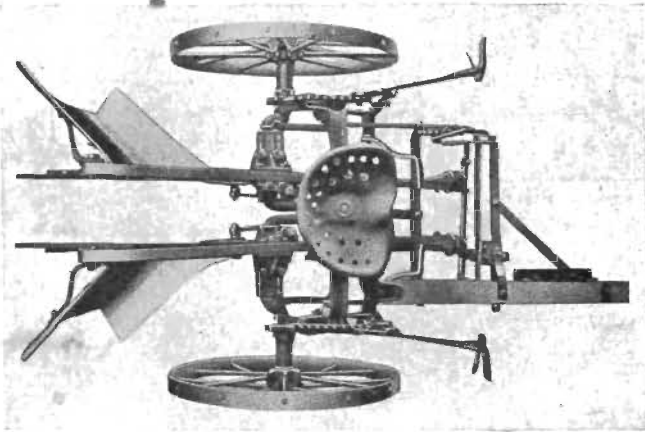


FIG. 101.- Two-way sulky plow.

125. The Gang Plow.—The gang plow (Fig. 103) has two or more bottoms. There is no material difference between the horse-drawn gang plow and the foot-lift or high-lift sulky except that a gang plow has more bottoms. The gang construction and arrangement of the wheels and methods of control are practically the same. Of course, it takes more horses to pull the extra bottoms and, when this is the case, greater trouble will develop from side draft, which will be discussed under Hitches.

SPECIAL RIDING PLOWS

126. Two-way Sulky.—This plow (Fig. 104) has two bottoms, a left-handed and a right-handed bottom. Only one of these bottoms is used at a time. One bottom is used going across the field in one direction and when, at the end of the furrow, the team is turned around, this bottom is raised and the other bottom is lowered into the soil. Therefore, by the use of the right- and left-handed bottoms, separately, all the

furrows are thrown in the same direction. It is a good plow to use on hillsides, terraced fields and on irrigated lands. It would also be good to use in small fields of irregular shape. Note that no dead furrows are left when a plow of this type is used. This would be advantageous to the

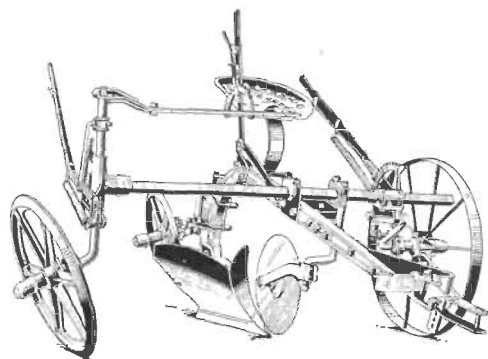


FIG. 105.—Frameless sulky riding plow converted into a middlebreaker or lister.

irrigated sections because the dead furrows left by the other types of plows will hold more water than is necessary and will likely cause a drowning out of plants. On terraced fields the soil washes down between terraces and partially fills the channel. Throwing the furrows up hill with a two-way plow somewhat offsets the down hill movement of the soil,

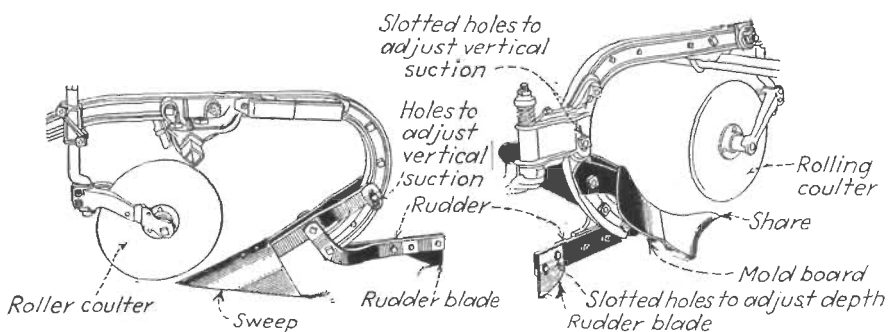


FIG. 106.—Sweep attachment for sulky plows.

FIG. 107.—Middlebreaker attachment for sulky plows.

helps in keeping the channel clear, and prevents the formation of bench terraces. When one bottom is raised and the other one lowered, the hitch automatically shifts to the proper position. The seat can also be tilted for use on hillsides, which assures comfort for the driver.

127. Riding Middlebreaker or Lister.—The riding middlebreaker (Fig. 105) is mounted on a truck of two wheels, having a seat for the operator. There are levers for adjusting the depth. The general construction and use have been discussed under walking middlebreakers.

A special sweep attachment and a middlebreaker attachment for sulky plows are shown in Figs. 106 and 107. Figure 108 shows a two-bottom middlebreaker or lister attachment for a tractor.

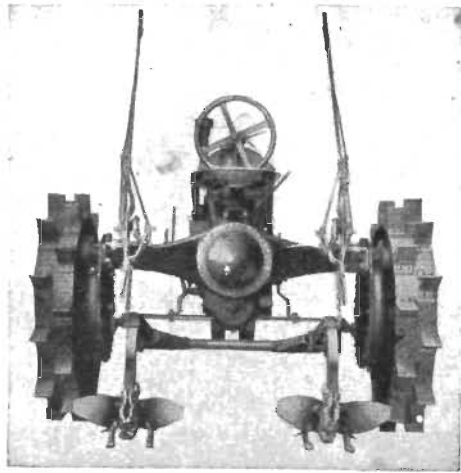


FIG. 108.—Two-bottom tractor-mounted middlebreaker or lister

128. The Steel Gang.—This is a plow constructed entirely of steel to give such strength that it will withstand the hard usage and the rough country of the western ranches (Fig. 109). Generally, no seat is placed on the plow; however, the operator can ride by placing a board across the

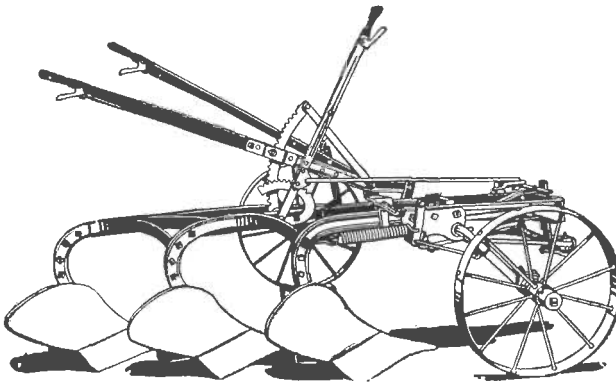


FIG. 109.—Steel-gang plow.

beams. This plow has only two wheels, the furrow wheel and the land wheel, no rear furrow wheel being used. The landside for the rear bottom is extra heavy and takes care of the rear adjustment. It has an extra long landing lever, a leveling lever, and a lifting lever.

ENGINE GANG PLOWS

129. Types of Engine Gang Plows.—The early type of plowing with engine gang plows was developed in England where a large steam tractor was stationed at each end of the furrow with a large drum pulley on which a cable was wound. One end of the cable was attached to each tractor

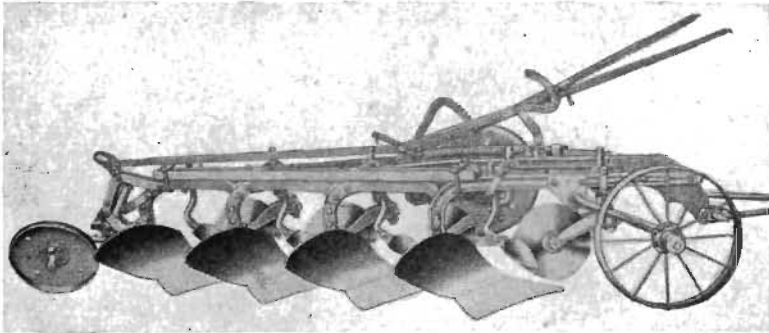


FIG. 110.—Four-bottom power-lift tractor plow.

drum. The plow was attached to the cable and alternately drawn backward and forward across the field by the tractors. This type of plow is still used, but it is a rather expensive way to plow due to the large amount of costly equipment necessary. The American idea is to hitch the plow behind the power and move tractor, plow and all, across the field together.

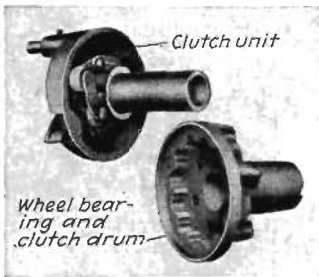


FIG. 111.—Clutch for power-lift on tractor plow.

130. The Power- or Unit-lift Gang Plow.—The power-lift plow (Fig. 110) is much smaller in construction and closely resembles the horse gang plow. In fact, it is possible to convert the horse gang plow into an engine plow by changing the type of hitch. In a power-lift plow the bottoms are lifted out of the ground as a single unit; that is, all bottoms being raised at one time.

This is accomplished by a special power-lift clutch (Fig. 111).

The tractor operator raises and lowers the plow bottoms by pulling a rope which causes the clutch to engage; the power of the tractor pulling the plow forward will raise it out of the ground. The plow is lowered into the soil by the operator pulling the rope, releasing the clutch, allowing the plow to drop on the ground, and, as the tractor pulls it forward, the down suction of the bottoms causes them to enter the soil. Tractor operators can control both the tractor and the plow when this type of plow is used. The land wheel runs vertically and straight forward. The front furrow wheel on some plows is set at an angle while on others it runs almost

vertical and straight forward. The rear furrow wheel is set very similar to that on the horse gang. It is sometimes given a lead away from the furrow wall while in other cases it is allowed to run straight to the front. Depth levers are provided for regulating the depth of the plows and also



FIG. 112.—Two-bottom plow drawn by a general purpose or row-crop tractor equipped with rubber tires.

for leveling them. The clutches found on this type of plow are exactly like those found on check-row planters except that they are much larger and stronger. It is of the ratchet and pawl type. All of the tractor plows are guided and controlled by the tractor. The hitch and various adjustments will be discussed under another heading.

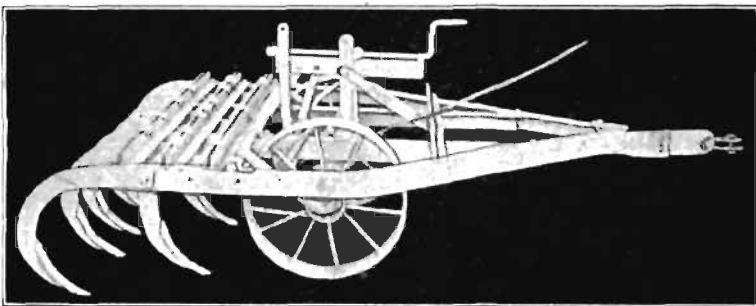


FIG. 113.—Chisel plow.

SPECIAL TRACTOR PLOWS

✓ 131. **Chisel Plow.**—Figure 113 shows a special type of tool that is called a *chisel* plow. It is claimed that it stirs the soil thoroughly without turning up the moist subsoil, thus leaving the dry soil on top; that it gives deep cultivations, breaking up hardpans and plow soles, which permits free movement of soil moisture and the absorption of a larger percentage of rainfall.

132. Power Subsoiler.—A special tool for deep penetration to break up subsoils and hardpans is shown in Fig. 114.

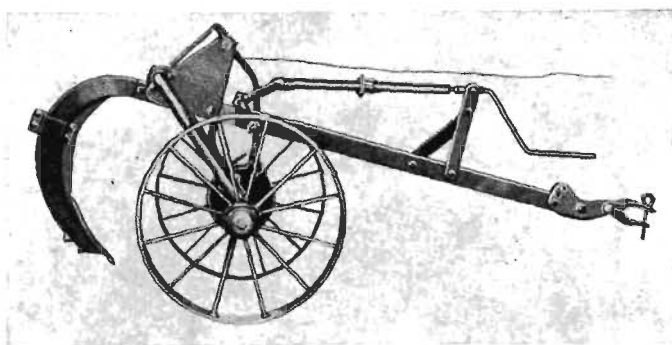


FIG. 114.—Power-lift subsoil plow.

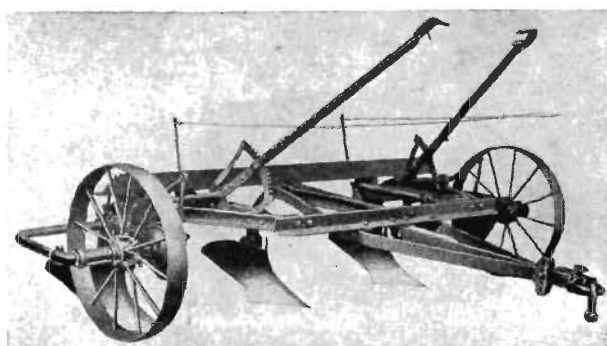


FIG. 115.—Three-bottom power-lift lister.



FIG. 116.—Two-row lister equipped with damming attachments.

133. Power-lift Lister.—In the semi-arid and wheat growing regions of the Middle West listing is often substituted for flat breaking with plows. Figure 115 shows a three-row lister or middlebreaker.

134. Basin or Damming Lister.—In areas where the soil has a tendency to blow and soil moisture is low, dams are made in the listed furrow with a damming attachment to form basins in which rainfall is stored (Fig. 116). The water collected in the basins soaks into the soil (Fig. 117)

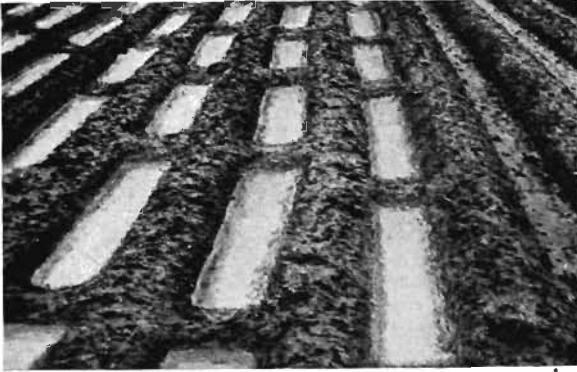


FIG. 117.—Illustrating how dams in lister furrows form basins to hold water.

providing moisture for crops, preventing soil and water losses by erosion, and aiding in checking wind erosion. The dams are formed with blades shaped to fit into a listed furrow so they will catch soil on the sides and bottom of the furrow. When the blade has moved forward 8 or 10 feet,

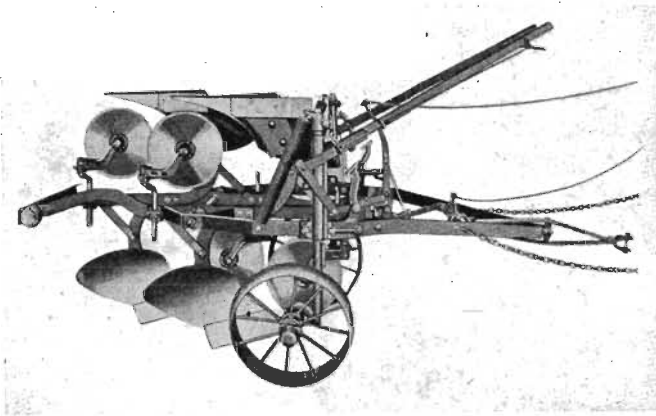


FIG. 118.—Reversible two-way tractor plow.

or enough to fill the furrow with soil, it is lifted over the soil, thus forming a dam. Several methods of lifting the blades or damming attachment have been developed. The most common, however, is a roller lug on one side of a gage wheel. As the wheel revolves, the lug comes in contact with an arched arm attached to the frame and lifts it and the blade, leaving a mound of soil in the furrow.

135. Draft of Basin Attachments.—Tests made at the Fort Hays Branch of the Kansas Agricultural Experiment Station with a two-bottom lister equipped with a basin attachment showed that the attachment increased the draft approximately 10 per cent. The draft of the two lister bottoms without the basin attachment on was 1,520 pounds,

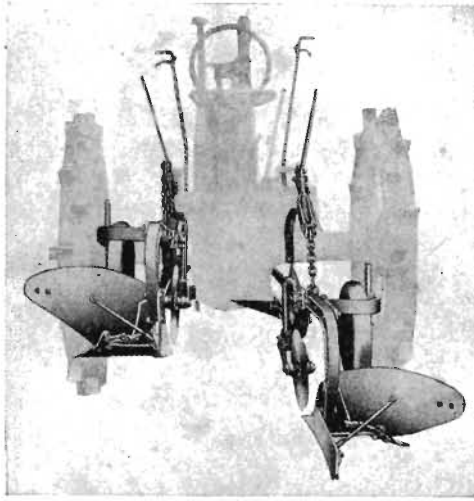


FIG. 119.— Two-way plow attachment for a one-plow tractor.

requiring 10.2 horsepower. With the basin attachment left off, the two lister bottoms gave a draft of 1,224 pounds, requiring 8.2 horsepower to draw the bottoms.

136. Two-way Tractor Plow.—The plows shown in Figs. 118 and 119 are tractor plows having both right- and left-hand bottoms. This type of plow is used in irrigated sections and where the land is to be broken without leaving dead furrows. It also can be used on terraced fields.

CHAPTER X

DISK-PLOW TYPES

The disk plow was brought out in an effort to reduce friction by making a rolling bottom instead of a bottom that would slide along the furrow. It cannot be said with authority that after the extra weight is incorporated into the plow it will have any less draft than that of the moldboard type. The results of the disk-plow usage, however, show that it is adapted to conditions where the moldboard will not work. Some of these conditions are as follows: first, the disk plow can be used in hard ground that is too hard for the moldboard; second, it will scour, using a scraper, in most soils; third, it does not form a hardpan; fourth, the angle of the disk can be changed for hard or loose land.

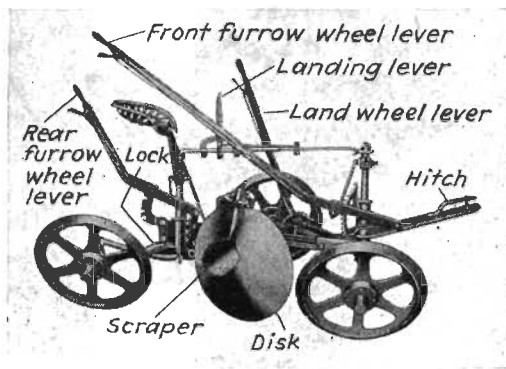


FIG. 120.—Sulky disk plow.

This type of plow is used in the South and North, and very extensively in the Southwest and the semi-humid regions of the Middle West. It is of special value in Texas because of the large areas of soil having a close texture which will not scour on the average moldboard plow. Texas is called by the plow manufacturers a *disk-plow state*. There are large areas, however, where the moldboard plow does work satisfactorily.

137. The Sulky Disk.—The sulky disk plow (Fig. 120) as in the case of the sulky moldboard plow, is a disk plow with only one bottom. The disk-plow bottom is a perfectly round, concave, disk of steel, sharpened on the edge to aid in the penetration of the soil. There are several holes for bolting this disk to the malleable casting upon which it fits. These disks

are set at an angle both to the plow sole and to the furrow wall. This allows the disk to have a sort of scooping action. The use of heat-treated disk-plow bottoms assures longer life, a smooth cutting edge, and easier penetration.

The malleable iron bracket to which the disk proper is bolted has an extension forming an axle projection, which fits into a hub in such a manner as to give a close-fitting bearing. These parts are usually chilled to increase their lasting and wearing qualities. Some plows are now being equipped with ball and roller bearings. The majority of plows, however, use plain cone bearings. The bearing allows the disk free action as far as turning is concerned.

When the plow is pulled forward the disk will turn due to the action of the furrow slice upon it. The top of the disk is revolving to the operator's left. The furrow slice, then, is cut by the left edge of the disk, brought under and up to the right, and then thrown out to one side. The furrow slice is pulverized to some extent when carried over the concave surface of the disk.

All disk plows should be equipped with a scraper (Fig. 120) which can be adjusted to work from the center to the edge of the disk. With the aid of the scraper it is possible to get greater pulverization of the furrow slice. It is also possible to invert the furrow slice much better.

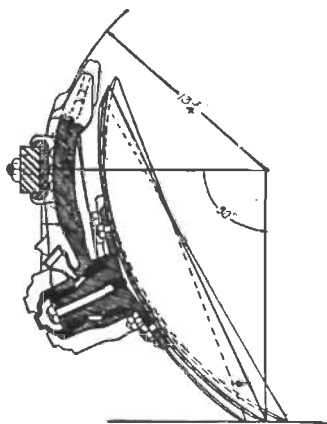


FIG. 121.—Vertical angle of disk can be easily changed.

The disk plow can be made to penetrate more easily by setting the disk more in a vertical position (Fig. 121). The flatter it is set the less tendency there will be for it to penetrate. To further enable the disk plow to take the soil properly, weight is added to the frame and wheels to force the plow into the ground. There is one great difference in moldboard and disk plows: The moldboard plow is pulled into the ground by the suction of the plow, while the disk is forced into the ground by adding weight and by the suction of the disk due to the angle at which it is set. The frame of this plow is made of very heavy steel with many large castings to give plenty of weight.

The wheels, instead of being made of light rolled steel as in the moldboard, are cast and are smaller and heavier. The rim of the wheels instead of being flat is usually flanged or V-shaped. This construction aids in preventing the wheel from slipping sideways. Provision is made for additional weight by means of weights which can be bolted between or

on the sides of the spokes of the wheel, usually on the rear wheel. This may be necessary if unusually hard ground is encountered.

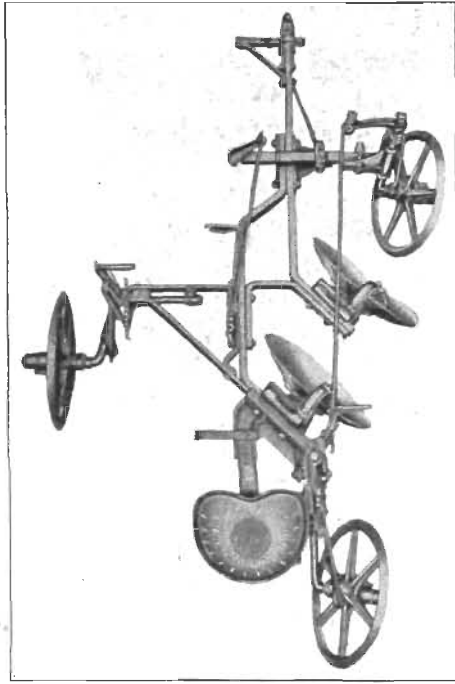


FIG. 122.—Overhead view of two-bottom horse disk-gang plow.

Another difference of construction, in comparison with moldboard plows, is that instead of the plow beams curving over the top of the

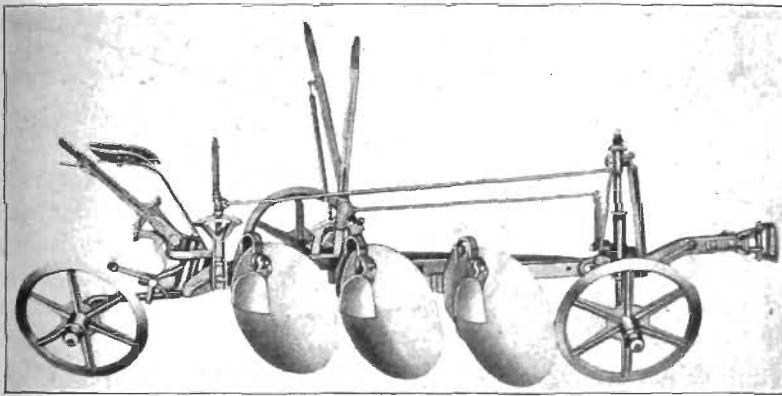


FIG. 123.—Triple-bottom horse disk-gang plow.

plow and attaching to the back of the plow bottom, they come from the side. This, of course, does not allow enough clearance and often gives trouble where a large amount of trash is on the land.

The furrow wheels of the disk plow, like those of the moldboard, are inclined. This is to aid the plow to overcome the side pressure created by the furrow slice upon the plow which is increased by the rolling of the bottom itself, causing the rear end of the plow to swing around to the left. There are levers for each of the wheels for adjusting and leveling the plow. There is a special lever for landing the front wheel, that is, it can be given more or less lead to or away from the furrow wall.

138. The Gang Disk Plow.—The gang disk plow (Fig. 122) differs from that of the sulky disk plow in that there are two or more bottoms. Many of the sulky plows are so constructed that they can be changed into a gang plow by adding another bottom, making either a two-disk (Fig. 122) or three-disk plow (Fig. 123). For this reason, this type of plow is sometimes called a *multiple gang plow*. The construction of the

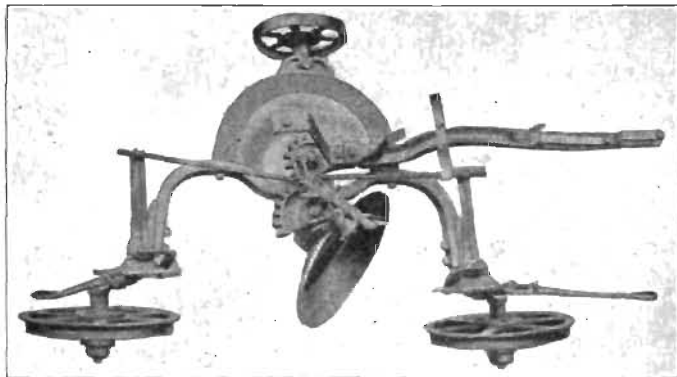


FIG. 124.—Overhead view of reversible-disk plow with seat removed.

disk, frame, wheels, and arrangement of the levers is practically the same as for the sulky plow.

SPECIAL HORSE-DRAWN DISK PLOWS

139. Reversible-disk Plow.—This disk plow consisting of one bottom (Fig. 124) is so constructed that the disk can be reversed and the soil thrown in the same direction at all times. The change from a right- to a left-handed plow or *vice versa* is accomplished by a beam that is pivoted at the center on one end of which is hitched the team, while at the other end there is a large semi-circle gear meshing with the gear on the bracket of the disk. If it is desired to turn the plow in the opposite direction, a latch is kicked loose releasing the beam and the team turns without turning the plow frame. As the beam revolves the disk is also turned by the action of the gear. The seat is attached to the beam and moves with it. The furrow wheels are adjusted automatically, changing the rear furrow wheel into the front furrow wheel and giving them the proper lead. This can be further adjusted by a special lever for that purpose.

ENGINE GANG DISK PLOWS

140. Regular Tractor Disk Plows.—Tractor disk plows may be divided into two classes according to the manner of construction of the frame; the side-frame type and the overhead-frame type. The side-frame disk plow (Fig. 125) is the original design and all engine disk plows were made with this type of frame until a few years ago. The frame

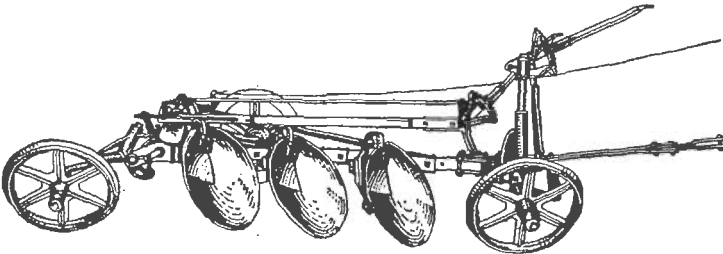


FIG. 125.—Side-frame disk plow.

fits to one side and below the top of the disk. The disk plow with the overhead frame (Fig. 126) has the frame elevated several inches higher so that the disk bottoms can be suspended underneath, giving more clearance. Manufacturers arrange the wheels differently. Some are arranged very similar to that of the power-lift engine gang moldboard plow. The wheels in the side-frame type of plow are arranged very awkwardly. The land wheel is placed out to the side and considerably

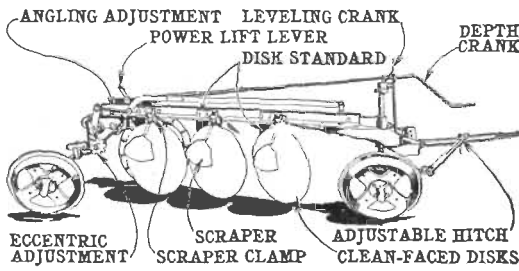


FIG. 126.—Overhead-frame engine gang disk plow.

to the rear of the plow, and furnishes the power for lifting the plow out of the ground. The front furrow wheel is placed to the front and connected to the hitch to aid in guiding and turning. The rear furrow wheel is often allowed to castor. The land wheel on the overhead-frame type may be placed near the front of the plow similar to the engine gang moldboard plow. The furrow wheels on both types are inclined from the vertical for the same reasons as in other plows. The rear furrow wheel is usually provided with heavy weights to force the plow into

hard soil. Levers are provided for adjusting the depth and leveling of the plow. The same type of power-lift clutch arrangement for raising and lowering the plow is used as on the moldboard type.

SPECIAL TRACTOR DISK PLOWS

141. One-way Disk Plow.—As shown in Fig. 127, the one-way disk plow is a combination of the principles of the regular disk plow and the disk harrow and is often termed a *wheat-land, cylinder, harrow, or tiller plow*. It has the frame, wheel arrangement, and depth adjusting devices of the disk plow, while the arrangement of the disks and their attachment to the frame is like the disk harrow. However, the disks are all set to throw the soil one way and turn together as a unit similar to a gang of a disk harrow. It is made in different sizes to cut strips 5, 6, 8, and 10 feet wide.

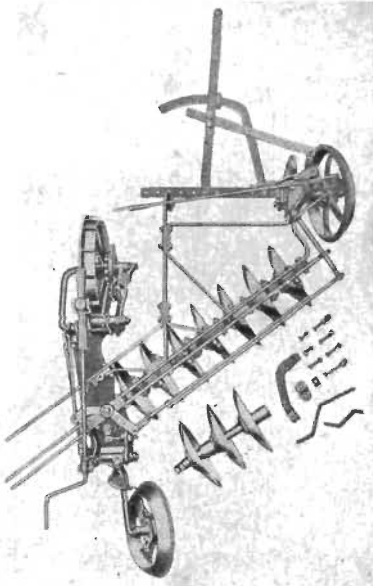


FIG. 127. Overhead view of one-way plow reduced to 7-disk size. Note disks and parts for increasing to 10-disk size.

The larger plows are constructed so that sections can be removed and the size of the plow reduced. It is claimed that 25 to 40 acres can be plowed in a day with the larger plows of this type. The size of disk used is generally 20 inches in diameter.

142. Orchard Disk Plows.

Figure 128 shows a disk plow constructed without any long levers to catch overhanging branches. The wheels are set inside the frame to allow passing close to trees. The hitch is

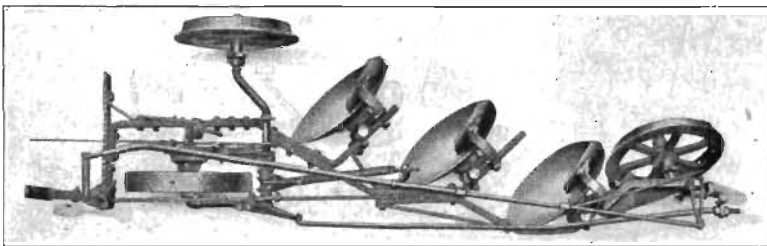


FIG. 128.—Special orchard disk plow.

designed to allow the plow to be shifted to either the right or left, which makes plowing close to trees possible.

143. Disk Plows for Special Tractors.—As in the case of the mold-board plows, manufacturers have designed and built disk plows adapted to special tractors.

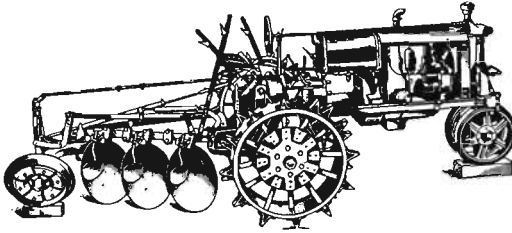


FIG. 129.—Disk-plow attachment for tractor.

The plow shown in Fig. 129 is designed to be drawn behind the tractor. These plows hitch directly to the tractor drawbar, eliminating the framework and front wheel. A power lift is provided to raise and lower the plow as desired. Two levers are placed conveniently to the operator for adjusting the depth and leveling the plow.

CHAPTER XI

PLOW DESIGN

The design of the plow is one of the big problems that has never been entirely solved, yet more work has been done to perfect the plow bottom than on any other agricultural implement. Upon its performance depends the quality of the seed bed the farmer can prepare, which in turn will influence the germination of the seed, the growth of the plant, and the yield that will be obtained in the end.

144. Judging Plowing.—Before going into the discussion of the design of the bottom for doing good plowing, one should consider first, what constitutes good plowing. Good plowing consists of turning and setting the soil into even, clean, straight furrows of roundish conformation. The main points to consider are the following:

1. The top of the furrow may be slightly ridged.
2. The soil must be pulverized thoroughly from the top to the bottom of the furrow.
3. Each furrow must be perfectly straight from end to end.
4. All back furrows must be slightly raised and all trash completely covered.
5. The outline of the furrows must be in a point without break or depression.
6. All trash must be buried completely in the lower right-hand corner of the furrow.
7. Furrows must be thoroughly uniform with one another.
8. The depth of all the furrows must be the same, continuing in uniform depth.
9. The dead furrows must be free from all trash on the ground.

These are rules by which a plowing test may be judged. However, if these rules were followed in all sections of the country where different types of soil are found, the best seed bed would not always be made. The main things to consider in plowing are that the land be completely broken, that the soil is thoroughly pulverized, and inverted, with no air spaces left between the furrows. These are conditions that may be applied to any section. The whole bottom is essential for good plowing, the share cutting and slightly lifting the furrow slice, the landside controlling and steadying the plow, while the moldboard completes the lifting, pulverizing, and inverting of the furrow slice. It is upon the moldboard that the main part of successful plowing depends. The curvature and length of the moldboard determine the degree of pulverization the furrow slice will be given.

145. Forces That Act on the Plow.—Lindgren and Zimmerman¹ analyze the many forces which act upon the plow bottom as follows:

¹ *Am. Soc. Agr. Eng. Trans.*, Vol. XV, p. 150, 1921.

First, the principal vertical forces: (a) that are due to the weight of the plow; (b) that are due to the downward pressure exerted during the lifting of the soil; (c) the lifting component due to the hitch being above the point of resistance; and (d) that force developed when the plow is dull and worn and which has the upward component the result of the sloping under surface of the share.

Second, the principal horizontal cross-furrow forces: (a) due to the cross-component caused by the friction of the soil on the moldboard; (b) by transferring the soil sideways the width of the furrow; (c) the cross-component due to cutting and wedging of the sloping share edge in operation; (d) the component of the line of draft; and (e) such cross-component as may result from the rear furrow wheel reactions in multiple outfits, where used.

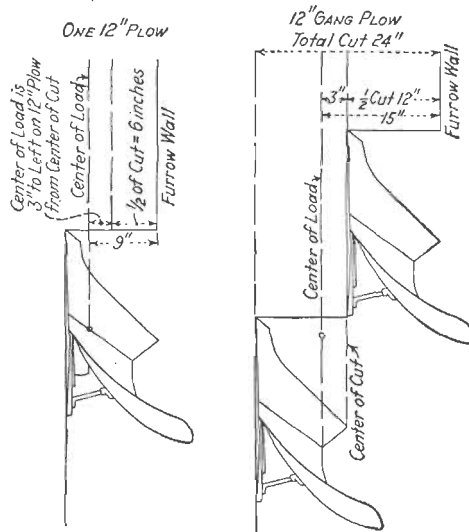


FIG. 130.—Showing the location of the center of load on a single-bottom 12-inch plow and on a two-bottom gang plow.

Third, the principal longitudinal forces acting lengthwise of the furrow: (a) the soil resistance to cutting; (b) the friction between the furrow wall and the landside; (c) the friction due to the weight and pressure upon the bottom of the plow according to the setting or condition of the cutting wedge; (d) the component of the friction of the earth sliding over the moldboard. For equilibrium we have the sum of the draft produced by the motive power.

Thus it can be seen that the moldboard which is a modified warped surface, as analyzed by White,¹ will have a great deal to do with the proper functioning of the plow, depending upon its width, curvature, and length. Moldboards which have a greater curvature, being bluffer, will naturally give a better pulverizing action upon the furrow slice, due to their pinching, crushing action.

¹ *Jour. Agr. Research*, Vol. XII, No. 4, p. 149, 1918.

146. Center of Resistance of a Plow Bottom.—A point where all three of these forces meet is considered to be the center of resistance or load. It cannot always be determined just exactly where this point will be on a plow bottom, but it will usually come within the range of the following dimensions for a 14-inch bottom. Vertical forces will be in equilibrium 2 to $2\frac{1}{2}$ inches up from the floor; the horizontal forces 2 to 3 inches to the right of the shin; the longitudinal forces 12 to 15 inches back from the point of the share. Briefly, we can say that the center of resistance of any moldboard plow bottom will be on top about where the share and moldboard intersect and to the right of the shin (Fig. 130). If two or more bottoms are used the center of resistance will be the average of all the centers. For a two-bottom plow it would be half way between the center of resistance for the two bottoms. On a three-plow outfit it would be at the center of resistance of the middle bottom. Of course, the style of bottom as to shape, type of share, and moldboard will influence the point where all the various forces acting on the bottom will be in equilibrium.

147. Influence of Friction on Design.—After taking all the above principles into consideration, they will resolve themselves into one general principle of plow design that must be considered in every type of plow, no matter whether it be stubble, general purpose, or sod. That principle is that friction will be the greatest at the point of the share and gradually decrease backward to the end of the moldboard. This can be seen readily on any plow bottom after considerable use. The greatest amount of wear is shown to be at the point and gradually decreases backward to the tip of the wing of the moldboard. This is why the stubble moldboard, which has a greater amount of curvature, gives better pulverization to the furrow slice. It is also seen that this type of moldboard will pick up the soil quicker and turn it over harder than any other type. That makes this type of plow more adaptable to plowing the loams and the sandy loam soils. The general purpose moldboard has a less amount of curvature than that of the stubble and it is in this class that the black-land type of plow will fall, because the curvature is not so pronounced as that of the stubble moldboard.

148. Influence of Speed on Design.—In the last few years there has been much agitation regarding the designing of plows for high speeds. It is not so difficult to design a plow for high speeds as it is to obtain pulverization. The bottom designed for high speeds must have gradual curves, which approach closely those of the sod type of plow. It can be seen readily that it is not necessary to have the moldboard as wide in this case in order to lift and invert the furrow slice. The higher velocity will carry the soil up over the moldboard, throwing it farther to the side. Much difficulty is likely to result from plows for high speed

which must incorporate a plow bottom of long slopes. They may scour well while going at a high rate of speed but when the speed drops to 2 or 3 miles per hour, the question is, will they continue to scour at this speed? Will they do the same type of work as at the higher speed?

149. Type of Soil.—Another important factor influencing plow design is the type of soil. In fact, if it were not for the soil factors, designing of plows would be a comparatively simple matter. Brown¹ says:

The type of soil, from sands, through the loams to the clays, are effected differently by the same plow bottom, and since the prime object of plowing is to put the soil in the proper condition of tilth for the successful growing of crops, it follows that there must be a variety of plow shapes.

Bacon² states that . . .

Plow designers have been obliged to make bottoms that will approach the best work in all conditions under which farmers plow. This accounts for the vast number of different designs of plow bottoms.

DISK-PLOW DESIGN

150. Uses of the Disk Plow.—In certain territories where plowing is extremely difficult, disk plows are used. The conditions adaptable to disk-plow use are enumerated as follows:

1. Sticky, waxy, gumbo, non-scouring soils, and soils having a hardpan or plow sole.
2. Dry hard ground that cannot be penetrated with a moldboard plow.
3. Rough, stony, and rooty ground, where the disk will ride over the rocks.
4. Peaty and leaf-mold soils where the moldboard plow will not turn the slice.
5. Clay and sandy loams.
6. Deep plowing.

151. Angle of Disks.—To successfully meet the conditions outlined, the disks' blades must be so arranged on the frame that they will function properly. From experience it has been found that the disks should be placed at an angle both vertically and horizontally. This angle depends on the proper distribution of the entire weight of the plow, which is necessary to hold the disks in the ground. Weight is required because the disks do not have the suction that the moldboard has. By referring to Fig. 121, it is seen that the vertical angle can be varied from an abrupt angle to one that is quite flat. The more vertical the disk is set, the greater the tendency to penetrate.

The horizontal angle of the disk influences the width of the furrow slice and the tendency to roll. Disk blades set more perpendicular to the direction of travel cut wider furrows and do not turn so freely as when more parallel to the furrow.

¹ *Am. Soc. Agr. Eng. Trans.*, Vol. XIX, p. 24, 1925.

² *Am. Soc. Agr. Eng. Trans.*, Vol. XII, p. 26, 1918.

152. The Center of Resistance.—The center of resistance is closer to the furrow wall than on moldboard plows. Its location is to the left and below the center of the disk blade. The point varies with the vertical and horizontal angles, the depth, and the amount of concavity of the blade.

153. Disk Blades.—The size of disk blades ranges from 20 to 28 inches. The average thickness for disk-plow blades is $\frac{3}{16}$ inch. The amount of concavity varies with both the different diameters and the same diameter, as shown in the table:

TABLE I.—SIZE, CONCAVITY, AND RADIUS OF THE AVERAGE DISK-PLOW BLADES¹

Size, inches	Concavity, inches	Radius, inches
20	$2\frac{7}{8}$	$18\frac{3}{4}$
23	$3\frac{1}{2}$	21
24	$3\frac{3}{8}$	$17 \times 30\frac{1}{2}$
24	$3\frac{1}{16}$	21
26	$3\frac{3}{4}$	$24\frac{1}{2}$
26	4	$23\frac{1}{16}$
26	$4\frac{1}{2}$	21
28	$4\frac{1}{4}$	$25\frac{1}{2}$
28	$5\frac{3}{8}$	21

¹ *Agr. Eng. Jour.*, Vol. VII, No. 5, p. 172, 1926.

CHAPTER XII

PLOW HITCHES

Next in importance to the problem of making a plow that will work under average conditions is the problem of hitching the plow to the prime mover, or the power that is to draw it. The hitching of horses requires different arrangements from that of tractors. The same principles, however, are involved, but they must be handled differently. The problem is to get all the pulling forces of the power and the resistance forces of the load in equilibrium, both vertically and horizontally.

154. Hitch.—The hitch is composed of the parts connecting the plow with the power. It may be simple, consisting of only one or two parts, or it may consist of a multiplicity of bars, braces, angles, and levers arranged to absorb certain vertical and horizontal forces.

155. Center of Power.—The center of power is often described as the *true point of hitch, or center of pull*. Whatever the term used, the point referred to is the center of the power, which is mostly horizontal, but the vertical forces must also be considered.

On a tractor it is the point where the drawbar is attached, which is always the middle of the tractor halfway between the wheels. In most tractors the drawbar can be shifted sidewise to compromise with the hitch on the tool. If horses are used, the center of power with one horse is midway between his shoulders or hame tugs (Fig. 135). If two horses are used, the center of power will be halfway between the two animals.

156. Center of Load or Resistance.—The center of load is often termed *center of draft*. As shown in Fig. 130, this is the point within the plow about which all the forces acting on the plow are balanced.¹

157. Line of Hitch.—The line of hitch or line of draft is an imaginary straight line passing from the center of load or resistance through the clevis or hitch to the center of power where the hitch is attached to the power. This definition applies to both the vertical and horizontal adjustment.

158. Side Draft.—Side draft is produced when the center of load or resistance is not directly behind the center of power. The center of load is out of line or to one side of the true line of hitch or draft. When side draft is present, there may be a pull sidewise on either the power or the load, depending upon the hitch.

¹ *Agr. Eng.*, Vol. 17, No. 1, p. 5, 1936.

It is a difficult problem to hitch a single-bottom plow attached closely to a fairly wide tractor. The center of power and the center of load are so close together longitudinally and so much out of line horizontally that a

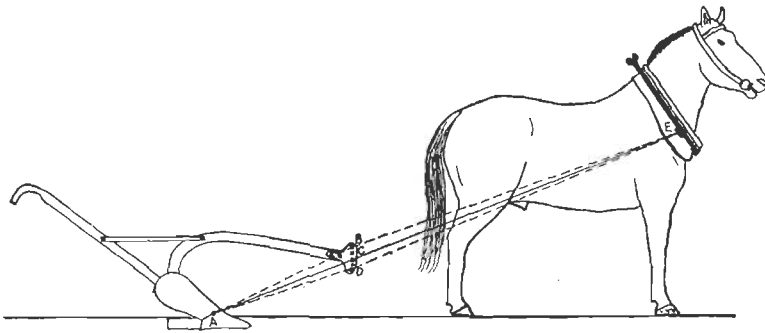


FIG. 131.—Vertical adjustment of hitch on horse-drawn plow.

good hitch is hard to obtain. In such a case the plow is put farther back, and some of the side forces are taken care of with a long landside and rear

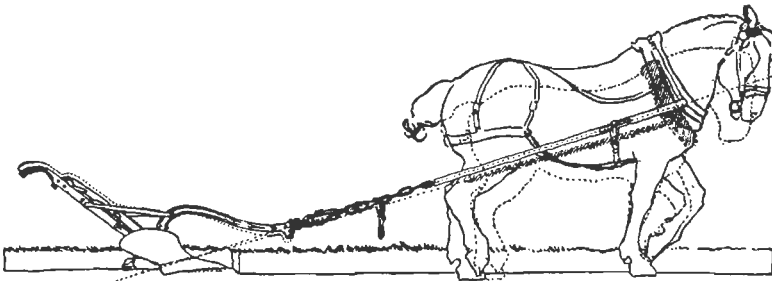


FIG. 132.—Hitch, showing the effect of different sizes of horses.

furrow wheel. Moving the plow farther back reduces the angle of pull with a wide power unit.¹

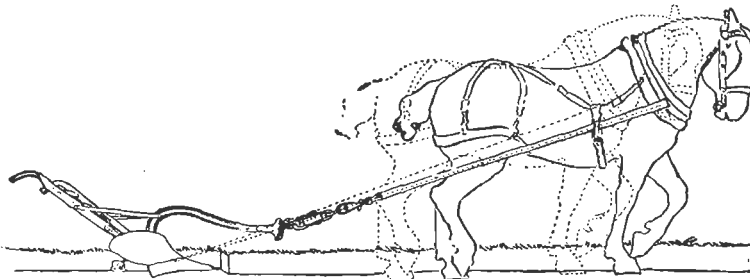


FIG. 133.—Showing the effect of a too short hitch.

159. Vertical Adjustment of Hitches.—With the horse as a source of power, the proper arrangement for the hitch is that there should

¹ *Agr. Eng.*, Vol. 15, No. 11, p. 387, 1934.

be a straight line extending from the center of resistance *A* (Fig. 131) through the clevis *C* to the point *E* where the tugs are fastened to the

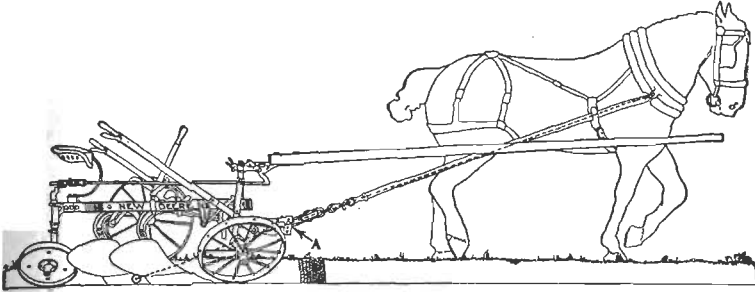


FIG. 134.—Correct hitch for a horse-gang plow.

hames. This should be the proper adjustment vertically. If the hitch at the clevis is too high, as *B*, the tendency will be to throw the plow deeper into the soil because of the fact that the line of hitch is seeking the straight line just mentioned. The reverse action will be true, if the hitch is lowered to *D* below that of a straight line. This principle applies to all horse-drawn plows from walking to gang, and also to tractor-drawn plows, both moldboard and disk.

160. Horizontal Adjustment of Hitches.—To hitch the plow to make it take the proper furrow width, the center of load or resistance must also be considered. A straight line must pass from the center of load through the clevis to the center of power between the tugs (Fig. 135). If the plow bottom is in perfect condition and the hitch properly adjusted, the ordinary walking plow should operate with very little assistance from the operator. When three or more horses are used, the hitch problem is greatly increased because the right-hand horse walks in the furrow throwing the other two upon the unplowed land so that the center of power does not coincide with the center of load, thus, creating side draft. Some operators attempt to remedy this on walking plows by the use of short eveners. The effect upon the team can be seen readily because the pull to the side causes additional trouble. A good length of singletree is 26 inches. For the good of the horse, nothing shorter than this should ever be used. It is even better to use a 28 or 30-inch singletree, which will give more clearance for the horse.

161. Balancing Teams.—When working two horses to a load, it is often found that they are not well matched. It is not an uncommon

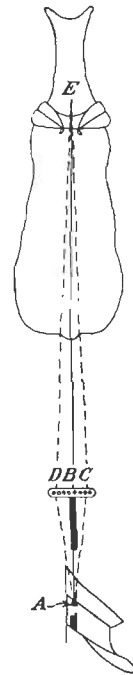


FIG. 135.—The center of the power should be directly ahead of the center of the load.

sight to see a heavy and a light horse being worked together. Naturally, the lighter horse is at a disadvantage. There are two ways of constructing the evener to correct this.

1. By adjusting the pin holes at the ends of the evener.
2. By adjusting the draft hole at the center of the evener

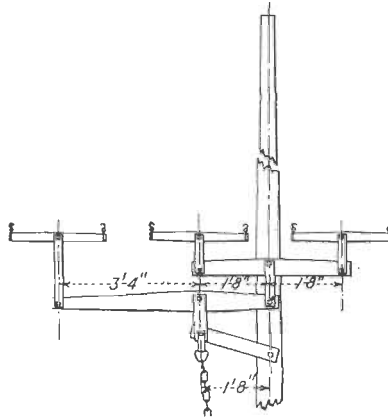


FIG. 136.—A three-horse evener for tongue implements.

Adjusting the pin holes at the ends of the evener is nothing more than making one end of the evener shorter than the other by having another hole closer in. The method used to determine the distance the hole is moved is shown by the following example: Assume that a team consists of a 1,500-pound and a 1,000-pound horse. The load each should

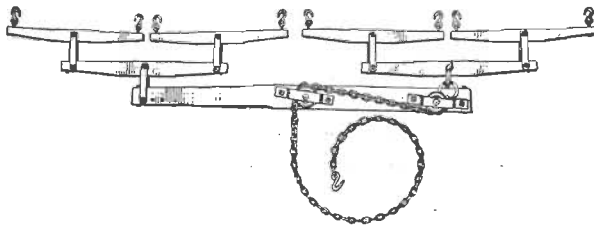


FIG. 137.—Four-horse evener constructed to help prevent side draft.

pull is 150 and 100 pounds, respectively. If the pin hole for the lighter horse is 24 inches from the draft hole, the length of the evener arm for the other horse is found as follows:

Take the length of the evener arm for the lighter horse and multiply that by the pounds it should pull. Divide the result obtained by the pounds the heavier horse should pull. The result will be the length of evener arm for the heavier horse.

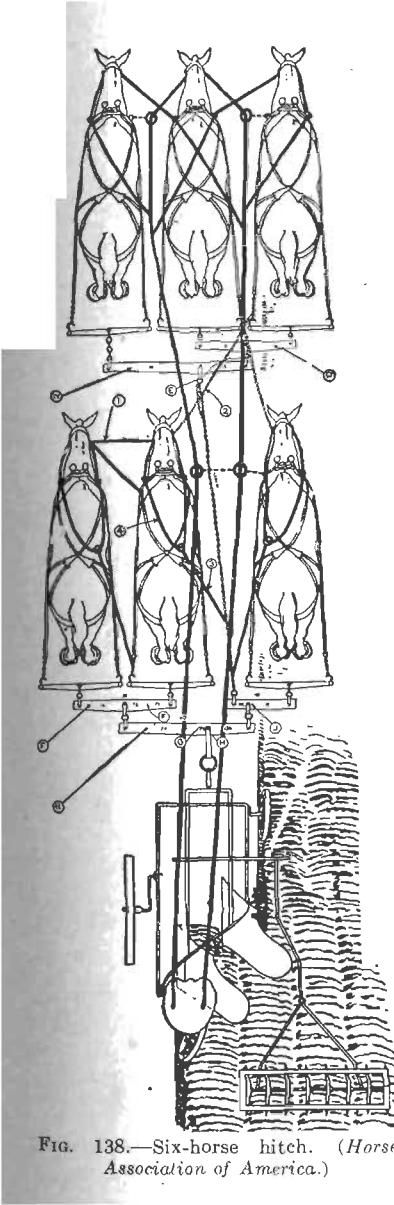


FIG. 138.—Six-horse hitch. (*Horse Association of America.*)

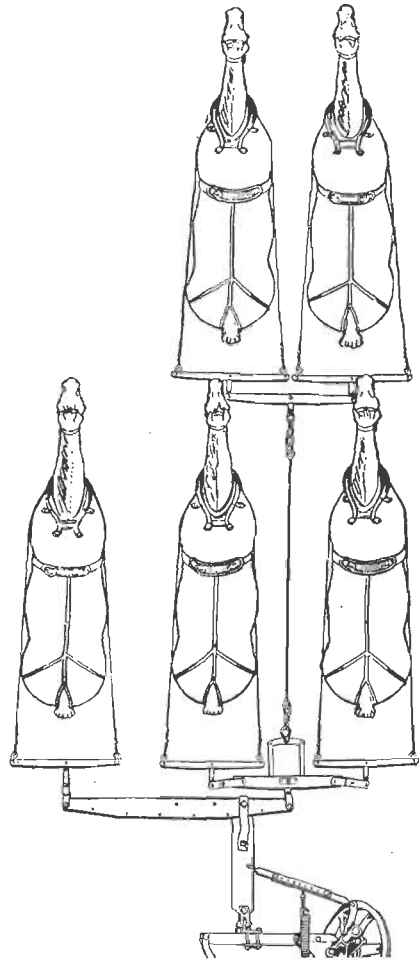


FIG. 139.—Commercial five-horse tandem hitch.

Hence:

$$\begin{aligned} 24 \times 100 &= 150 \times X. \\ 150X &= 2,400. \\ X &= \frac{2,400}{150} \\ X &= 16. \end{aligned}$$

When the draft hole is used it is moved only half the amount the pin hole was moved, because 1 inch at the draft hole is equivalent to 2 inches, since it means 1 inch on each end of the evener. The length of the ends is obtained by the same method as with the pin holes.

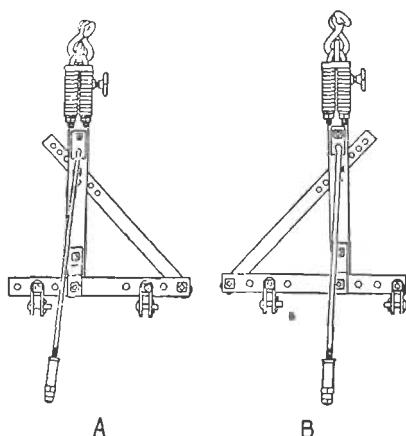


FIG. 140.—Typical hitch used on moldboard plows. Note spring release. A, hitch set for 2-furrow 12-inch plow; B, hitch set for 2-furrow 14-inch plow.

This rule will work equally well for a three-, four-, or five-horse evener when two or three horses are considered as one.

162. Multiple Horse Hitches.—In this modern age where efficiency is a password and more acres and horses per man is the cry, much interest is being shown in big-team hitches. The construction of hitches to allow as many as 16 or more horses to work together is comparatively a simple task.

The Horse Association of America has a number of excellent combinations, one of which is shown in Fig. 138.

Farmers often write in and ask, "How can I hitch six horses abreast, without side draft, to a disk plow and have all the horses walk on the unplowed ground except the right one?" The answer is, "It can't be done." However, Fig. 137 shows a special hitch, manufactured by a number of concerns, that allows hitching abreast and partially compensates the side draft. The best way to solve such a problem is to hitch the horses tandem as shown in Figs. 138 and 139.

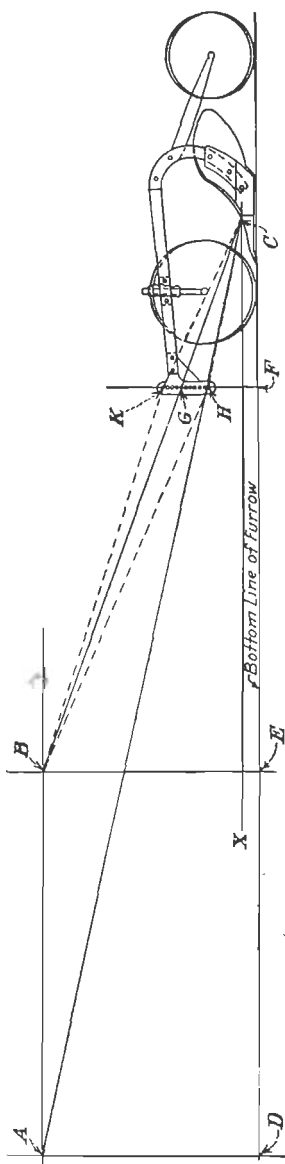


Fig. 141.—The correct vertical hitch in *BGC* for a short hitch and *AHC* for a long hitch.

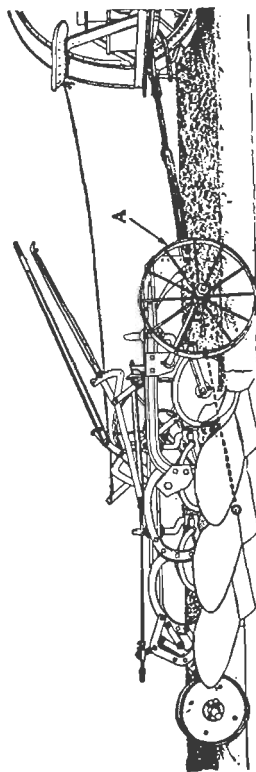


FIG. 142.—Correct angle of hitch for three-bottom tractor plow.

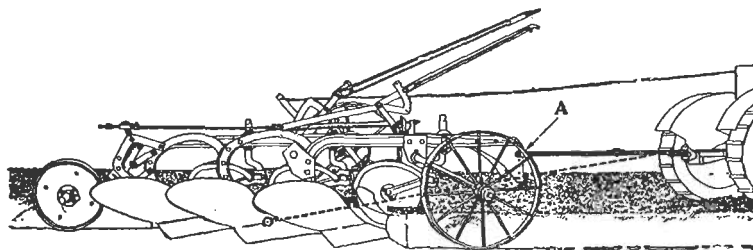


FIG. 143.—Hitch too high at A.

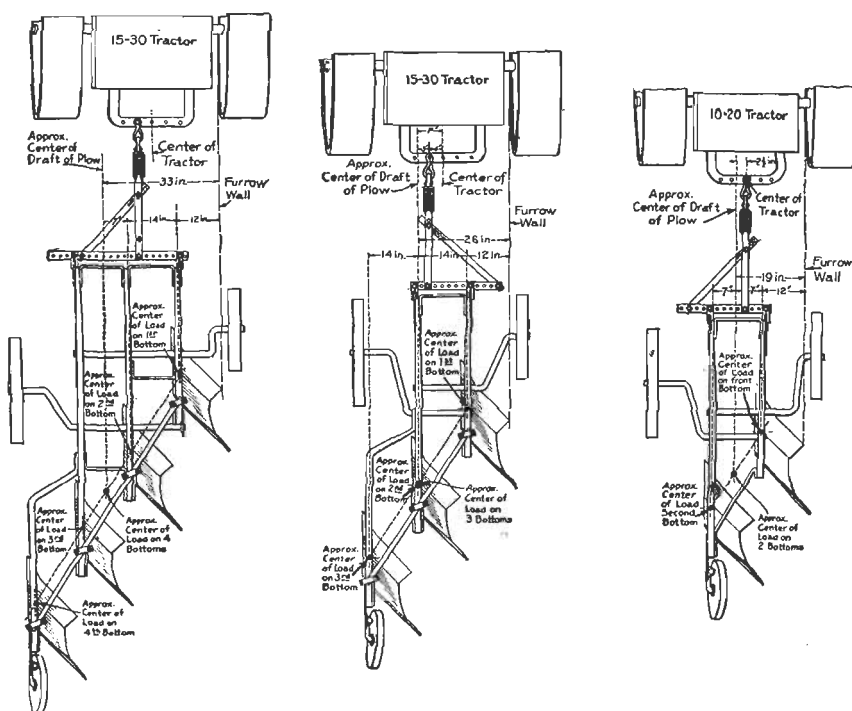


FIG. 144.—Horizontal tractor hitches for two-, three- and four-bottom plows with right wheels of tractor in furrow.

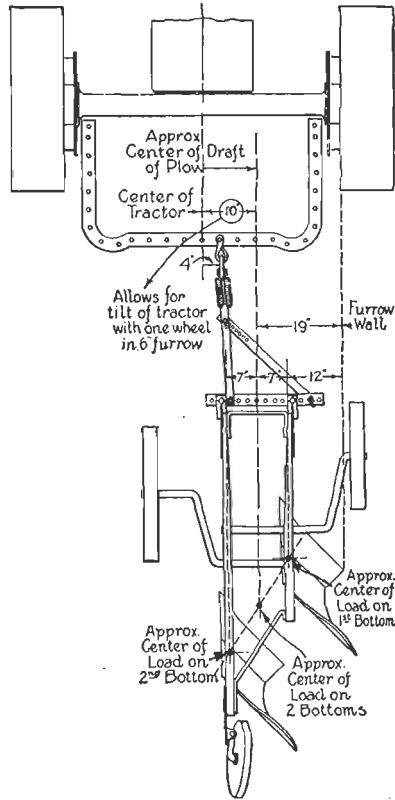


FIG. 145.—Horizontal hitch for two 14-inch plow bottoms to a general purpose tractor.

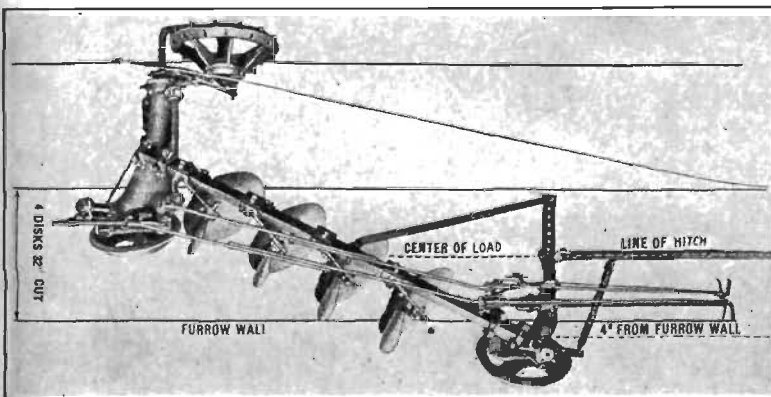


FIG. 146.—Illustration shows a four-disk tractor plow, each disk cutting 8 inches, making the total cut of the plow 32 inches. One-half the total cut, measured from top of furrow wall, is 16 inches, or the center line of draft on this plow. The center of cut is always the line of draft on a disk plow.

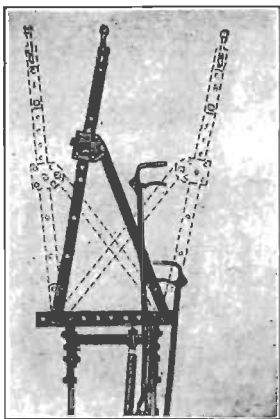


FIG. 147.—Special hitch for tractor orchard plows.

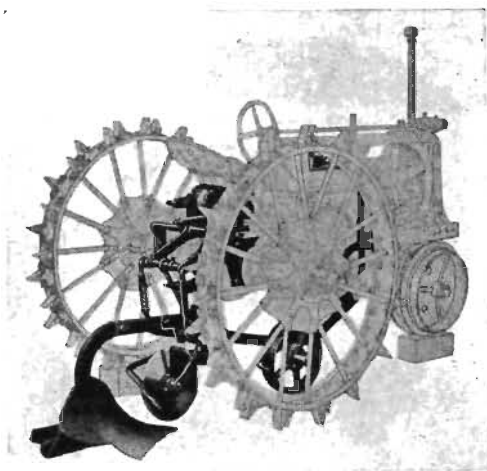


FIG. 148.—Plows for the small one-plow general purpose tractor are hitched underneath, between the front and rear wheels to compensate side draft.

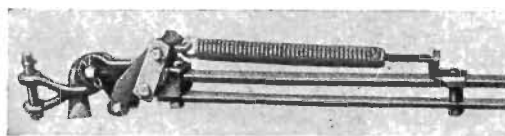


FIG. 149.—Spring release hitch for disk plows.

163. Tractor Plow Hitches.—With the advent of the tractor to furnish power for pulling farm tools, the problem of hitching in such a manner as to eliminate side draft on both the plow and the tractor must be studied. Plow designers have worked out many different arrangements, but the hitch in general use is of the type shown in Fig. 140. Of

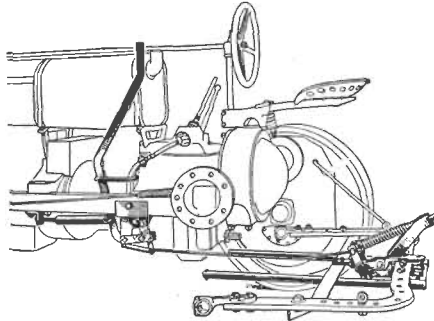


FIG. 150.—A tractor stop hitch. When stop hitch is tripped, the engine clutch is automatically disengaged. The tractor is stopped before the plow is uncoupled. The plow is uncoupled without the operator's getting off the seat.

course, there are many kinds of this type of hitch differing only in the way the parts are fitted together and means of adjustment.

Tractor hitching, like horse hitching, is a question of hitching in such a way that there will be no side draft—at least as little as possible. So again it is necessary to have the center of power and center of load coincide with the line of hitch—both vertically and horizontally.

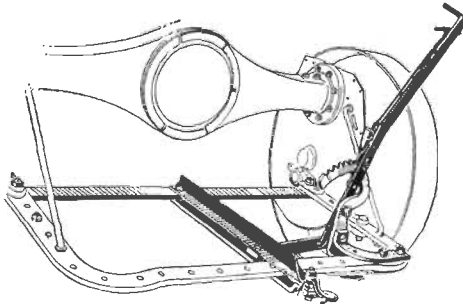


FIG. 151.—Hitch for use with tractor plows when on hillsides to keep plow in proper position and prevent it from sliding down-hill.

Figure 141 shows the correct vertical adjustment for a tractor and plow when the line of hitch is *BGC*. If the hitch at the clevis is raised to *K*, there would be a tendency for the pull to seek the true line of hitch and, consequently, there would be a downward force at *K*, causing extra weight on the front wheels of the plow, while the rear wheel would be relieved of a part of its load. If the hitch is changed to *H*, part of

the weight of the plow would be supported by the tractor. The extra pressure would be transferred to the rear wheel.

Figure 142 shows correct hitching while Fig. 143 shows the hitch at A too high.

Figures 144 to 147 show horizontal tractor hitching for different size plows. With most of the smaller outfits, it is necessary to run the right wheels of the tractor in the furrow in order to bring the center of power over as far as possible, in front of the center of load. This greatly reduces the side draft.

CHAPTER XIII

DRAFT OF PLOWS

Plowing is recognized as the greatest labor-consuming operation in the world. There is no doubt that it is the job on the farm that takes the most power. It is important that every effort should be made to reduce this power used to the minimum in keeping with good practice. Davidson gives the following factors which must be considered in determining the actual draft of the plow:

Depth of plowing, width of plow, character of soil, moisture, previous treatment of soil, smoothness of surface, shape of moldboard, sharpness of share; rigidity of plow, and speed.

164. Draft as Affected by Depth of Plowing.—It is almost impossible to make a plow run at a constant uniform depth no matter how well it may be adjusted. Naturally, the deeper the plow penetrates the soil, the more draft there will be. Tests indicate that a 14-inch plow will increase in draft an average of 92 pounds for each inch increase in depth.¹ Taking into consideration the whole United States and the various conditions encountered in the various parts of the country, and the different types of plows used, whether walking, gang, or tractor plow, the average depth of plowing for all these conditions will be around 5 inches. The draft of any plow can be determined by an instrument called a *dynamometer*, which registers the pull or draft of the plow over a measured distance. Then, knowing the speed of the team and the time it took to travel this distance, the horsepower, as well as the average draft per unit of the cross-section of the furrow slice, can be determined.

$$\text{Horsepower} = \frac{\text{force} \times \text{distance traveled in feet per minute}}{33,000}$$

165. Plow Draft as Affected by the Width of the Furrow.—As in the case of the depth of the plow affecting the draft of the plow, the width of the furrow will also affect it. Naturally, the wider the plow, the more soil will be turned over and the more draft there will be. The width of furrow that a plow cuts cannot be controlled absolutely. This is especially true in the walking plow. With the gang plow, however, the bottoms are spaced equally and if the plow is properly adjusted to cut its

¹ *Am. Soc. Agr. Eng. Trans.*, Vol. XIV, p. 44, 1920.

proper width of furrow, and all other factors are working perfectly, each bottom will cut a constant uniform width of furrow. It does not follow that each furrow slice will give the same resistance. There are some natural influences that will affect the resistance of furrows. Usually, the draft of the plow is given in the number of pounds pulled per square inch of the cross-section of the furrow slice. To determine this, the depth and width of furrow must be considered. The number of square inches in a cross-section of a furrow slice can be determined by multiplying the depth by the width of the furrow. That is, a plow going 6 inches deep and cutting the furrow slice 14 inches wide will give a cross-sectional area of 84 square inches. Then, if the total draft for the whole plow is 500 pounds, the draft per square inch would be 500 divided by 84, or 5.95 pounds per square inch.

166. Character of Soil.—The character of the soil, whether it be sandy, clay, loam, or blackland will have a great deal to do with the number of pounds pulled or draft of the plow. A less number of pounds is required to pull a plow in sandy soil than in a stiff gumbo or clay soil. The draft of the plow is affected by soil conditions as well as the type of soil, and will range from 2 to 3 pounds up to 20 pounds per square inch.

167. Moisture.—The amount of moisture in the soil will also affect the draft or total pounds required to move the plow. The amount of moisture frequently will determine the time when the plowing should be done, whether it should be in the spring or in the fall. When there is a good season, or plenty of moisture in the soil, the draft is not so great as when plowing is attempted when the ground is hard and dry. When the ground is very hard, the plow will not penetrate the soil easily. This, in itself, will indicate that the draft will be increased, owing to lack of moisture.

168. Previous Treatment of the Soil.—The draft of the plow will be influenced to a considerable extent by the previous treatment to which the soil has been subjected; that is, whether it has been properly plowed and cultivated, whether the crop planted on the soil before was cultivated, whether it was harrowed by a disk harrow before being plowed, or allowed to go untreated. The amount of straw and organic matter that may have been covered by a previous plowing will also affect the draft because organic matter will cause the soil to become mellow and break up easier.

169. Smoothness of Surface.—If the surface of the soil is uneven, naturally, the water will collect in the low places and leave the high places without the required amount of moisture. Then, of course, when the plow comes to the moist places it will plow easier than where there is a lack of moisture, so that the draft is affected directly from the unevenness of the ground. While, if the plow is a gang plow of the unit type and the surface is not even, some of the plows will go much deeper than others,

causing an overload. Up and down hill causes heavy draft one way and light the other.

170. Shape of Moldboard.—As has already been indicated, the draft of the plow will be affected by the shape of the moldboard, whether stubble, general purpose, blackland, or sod. The tests run by Ocock¹ indicate, to some extent, the difference of draft as effected by the shape of the moldboard. The results of his tests show that the stubble moldboard gives a greater draft than that of the sod moldboard, and the general purpose comes in between these. His conclusions were that the more abrupt the curve, the greater the draft. The less curvature there is to the moldboard, the less the pulverizing action upon the furrow slice and, naturally, the less pressure will be exerted upon the surface of the moldboard, resulting in less draft. Collins² found, in his tests at Ames, Iowa, that the type of bottom did not materially influence the draft; that an increase in speed produced about the same increase in draft with any type of bottom. Upon analyzing the results, it is shown that a sod bottom has a long section of furrow slice which is carried on the share and moldboard and it must be pushed off. The greater area in contact results in a corresponding increase in frictional resistance and draft.

171. Sharpness of Share.—The share must cut the furrow slice loose from the ground and a large percentage of the draft of the plow results from cutting the furrow slice loose. As a result of some tests made by Collins² to determine the draft necessary for cutting and turning the furrow slice, and the draft of the plow alone, he has the following to say:

The draft of the plow on the ground, 18 per cent; draft due to turning furrow slice, 34 per cent; draft due to cutting slice, 48 per cent.

Thus, it is seen that practically 50 per cent of the total draft of the plow is used in cutting the furrow slice. A test was run to determine the effect of dull shares and sharp shares upon the draft of the plow. In a test on sandy loam soil the difference in draft of a sharp share was almost negligible. In a field of bluegrass sod there was a difference of 14 per cent in favor of the sharp share. In soil that is soft and mellow the sharpness of the share will not matter so much, but if there are many roots or the soil is comparatively hard or lacks moisture, a sharp share is to be advocated.

172. Hitch.—The angle of hitch will also affect the draft of the plow. If the angle is short and sharp and the implement hitched close to the point of power, there will be a tendency to lift the plow which will take

¹ *Am. Soc. Agr. Eng. Trans.*, Vol. VI, p. 13, 1912.

² *Am. Soc. Agr. Eng. Trans.*, Vol. XIV, p. 39, 1920.

some of the weight of the plow off the ground and slightly decrease the draft. The reverse will be true if the hitch is farther away.

173. Rigidity of Plows.—Some plows may not be constructed rigidly enough to secure a uniform depth of penetration and a uniform width of furrow. It is important that they should be, because of the effect that the depth and width of the furrow will have upon the draft of the plow.

174. Speed.—Some tests have been made to determine the effect of speed on the draft of plows. All these tests have shown conclusively that there is an increase in draft as the speed increases. The results of the tests made in California by Davidson, Fletcher, and Collins¹ were as follows:

In clay loam speed 1 mile per hour—draft, 100 per cent. Speed 2 miles per hour—draft 100 to 114 per cent. Speed 3 miles per hour—draft 128 per cent. Speed 4 miles per hour—draft 142 per cent.

Tests in Iowa black-loam soil gave the following results:

Speed 1 mile per hour—draft 100 per cent. Speed 2 miles per hour—draft 117 per cent. Speed 4 miles per hour—draft 126 per cent.

The conclusions were: that an increase of the field speed of a plow with a general purpose moldboard, from 2 to 3 miles per hour, resulted in an increase of draft from 8 to 12 per cent, varying with the soil. Doubling the speed will result in an increase of draft from 16 to 25 per cent. The amount of work accomplished is increased from 50 to 100 per cent, respectively. It is to be remembered that practically 50 per cent of this task of plowing is consumed in cutting the furrow slice. The conclusions reached by Collins in his tests in Iowa, in

TABLE II.—RATE OF TRAVEL

Miles per hour	Feet per minute	Miles per hour	Feet per minute
1	88	4	352
1 $\frac{1}{4}$	110	4 $\frac{1}{4}$	374
1 $\frac{1}{2}$	132	4 $\frac{1}{2}$	396
1 $\frac{3}{4}$	154	4 $\frac{3}{4}$	418
2	176	5	440
2 $\frac{1}{4}$	198	5 $\frac{1}{4}$	462
2 $\frac{1}{2}$	220	5 $\frac{1}{2}$	484
2 $\frac{3}{4}$	242	5 $\frac{3}{4}$	508
3	264	6	528
3 $\frac{1}{4}$	286		
3 $\frac{1}{2}$	308		
3 $\frac{3}{4}$	330		

¹ *Am. Soc. Agr. Eng. Trans.*, Vol. XIII, p. 69, 1920.

1920, were that the increase in draft, due to speed, is applied to that part of the total which is required for turning and pulverizing. This varies with the speed from less than one-third to about one-half the total draft of the plow within a range of 2 to 4 miles per hour.

Studies made in Ohio by Ashley, Reed, and Graves¹ indicated that the average increase in draft, due to increased speeds, with two bottoms was 1.17 pounds per square inch of furrow slice for each mile per hour increase in speed.

TABLE III.—CHART SHOWING ACRES COVERED PER HOUR WITH DIFFERENT WIDTHS OF IMPLEMENTS AT VARIOUS SPEEDS¹

Ft.-In. (1)-12.	Acres per Hour	Miles per Hour
14.	$\frac{1}{8}$	$\frac{1}{4}$
16.	$\frac{3}{16}$	$\frac{1}{2}$
18.	$\frac{1}{4}$	$\frac{3}{4}$
20.	$\frac{5}{16}$	1
22.	$\frac{3}{8}$	$1\frac{1}{4}$
(2)-24.	$\frac{7}{16}$	$1\frac{1}{2}$
26.	$\frac{1}{2}$	2
28.	$\frac{5}{8}$	$2\frac{1}{4}$
30.	$\frac{3}{4}$	$2\frac{1}{2}$
32.	$\frac{7}{8}$	$2\frac{3}{4}$
34.	1	3
(3)-36.	$1\frac{1}{8}$	$3\frac{1}{4}$
38.	$1\frac{1}{4}$	$3\frac{1}{2}$
40.	$1\frac{3}{8}$	$3\frac{3}{4}$
42.	$1\frac{1}{2}$	4
44.	$1\frac{5}{8}$	$4\frac{1}{4}$
46.	$1\frac{3}{4}$	$4\frac{1}{2}$
(4)-48.	2	$4\frac{3}{4}$
51.	$2\frac{1}{4}$	5
54.	$2\frac{1}{2}$	$5\frac{1}{4}$
57.	$2\frac{3}{4}$	$5\frac{1}{2}$
(5)-60.	3	$5\frac{3}{4}$
63.	$3\frac{1}{4}$	6
66.	$3\frac{1}{2}$	$6\frac{1}{4}$
69.	4	$6\frac{1}{2}$
(6)-72.	$4\frac{1}{4}$	$6\frac{3}{4}$
75.	$4\frac{1}{2}$	7
78.	$4\frac{3}{4}$	$7\frac{1}{4}$
81.	5	$7\frac{1}{2}$
(7)-84.	$5\frac{1}{4}$	$7\frac{3}{4}$
90.	$5\frac{3}{4}$	8
(8)-96.	6	$8\frac{1}{4}$
102.	$6\frac{1}{2}$	$8\frac{1}{2}$
(9)-108.	7	$8\frac{3}{4}$
114.	$7\frac{1}{2}$	9
(10)-120.	8	$9\frac{1}{4}$
	$8\frac{1}{2}$	$9\frac{1}{2}$
	9	10

Usual
Range
of
Horse
Speeds

¹ Copyrighted, 1933, by International Harvester Company of America, Inc. (Used by special permission of the company.)

¹ Progress Report on Draft of Plows Used for Corn Borer Control, U. S. Dept. Agr., Bur. Agr. Eng., 1932.

175. Rate of Plowing.—One 14-inch plow bottom pulled at the rate of $2\frac{1}{2}$ miles per hour will plow approximately $1\frac{1}{32}$ or 0.3 acre in 1 hour. Some time, however, must be allowed for turning which will depend on the shape and size of the field and how it is laid out. For example, with a two-plow outfit in a field 80 rods long, where lands of average width are struck out and the turning is done on headlands, about 6 per cent of the time is spent in turning at the ends. Table III shows the acreage plowed with different width plows when drawn at different speeds.

A four-plow outfit, of course, will accomplish about twice as much as the two, if both are run at the same speed; and a six-plow outfit twice as much as the three-plow outfit. One acre contains 43,560 square feet, or 160 square rods. A 14-inch furrow 1 mile long equals 6,160 square feet.

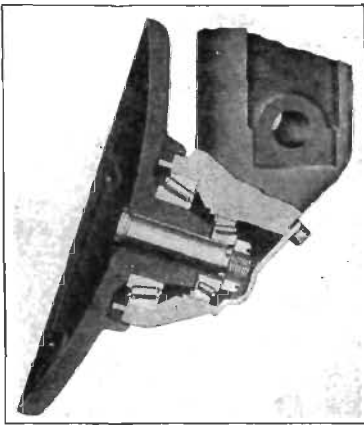


FIG. 152. Cross-section of roller bearing for disk plow.

176. Draft as Affected by Attachments.—Ashley, Reed, and Graves¹ found that two 10-foot wires increase the draft about 2 per cent, an ordinary jointer absorbs about 7 per cent of the power when used with a coulter, and the jointer alone requires less power than a combination coulter and jointer. They found that the covering wires, coulter, and jointer together absorb

between 10 and 15 per cent of the total power required to pull the plow with attachments.

177. Effect of Grades.—When on a grade, the effective drawbar pull of a tractor is lessened 1 per cent for each per cent of grade. For example, the weight of the tractor ready for work with an operator and a three-bottom plow is approximately 7,600 pounds. To negotiate a 10 per cent grade with this outfit would require an additional power equivalent to a pull at the drawbar of 760 pounds.

178. Other Factors Affecting the Draft of Plows.—Scouring of plows will influence the draft. If there is a smooth, polished surface for the soil to slip over, it is obvious that there will be less friction and draft.

The weight of the implement cannot be overlooked. A heavy bulky machine will pull heavier than one that is light.

179. Draft of Disk Plows.—Practically all draft tests on plows have been made with the moldboard type. The few made with the disk plow seem to indicate that it is slightly lighter in draft than the mold-

¹ Progress Report on Draft of Plows used for Corn Borer Control, U. S. Dept. Agr., Bur. of Agr. Eng., 1932.

board, when plowing under similar conditions and turning the same volume of soil. The type of soil is the greatest external factor to consider in the draft of any plow. In very hard ground, it is often necessary to add weight to the wheels to force the plow into the soil. Of course, the added weight will create more draft.

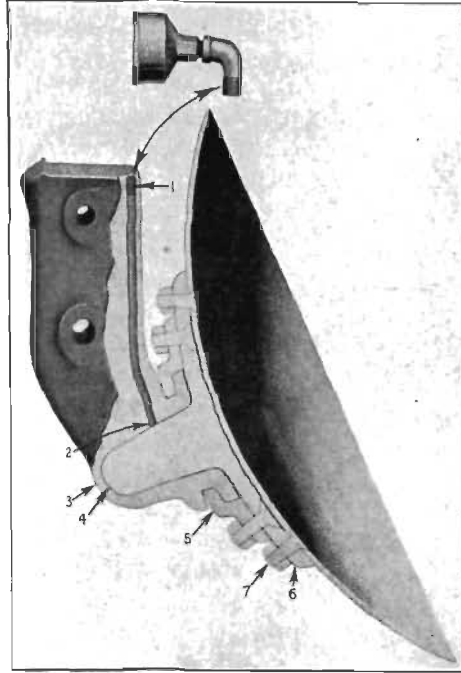


FIG. 153.- Cross-section of cone-type disk-plow bearing: 1, point where grease cup is attached; 2, oil tube; 3, cup for cone; 4, cone; 5, flange to hold bearing in place; 6, disk casting to hold disk blade; 7, bolt to hold disk blade.

Factors incorporated in the plow are very important. The bearings of the disk-plow blade affect the draft. According to tests conducted by Hardy¹ a plain cone bearing will pull 23 per cent heavier than a ball or roller bearing. Figure 152 shows a roller bearing, while Fig. 153 shows a plain cone bearing.

The type of scraper used to clean the disk will also affect the draft. Hardy's tests indicate that the revolving type gave slightly less draft than the spade type.

¹ HARDY, E. A., Univ. Saskatchewan, Saskatoon, Canada.

CHAPTER XIV

PLOW TROUBLES, ADJUSTMENTS, DUTY, COST OF OPERATION AND LAYING OUT FIELDS FOR PLOWING

The efficiency of any farm machine depends, largely, upon the elimination of troubles. Each class of plow, moldboard, and disk, as well as each type of walking, riding, and horse- and tractor-drawn plows has troubles and adjustments which are common to all. They also have troubles and adjustments that are applicable only to one certain type.

WALKING-PLOW TROUBLES

180. Running Too Deep.—Running too deep is a common trouble, making it necessary for the operator to keep pressure upon the handles.

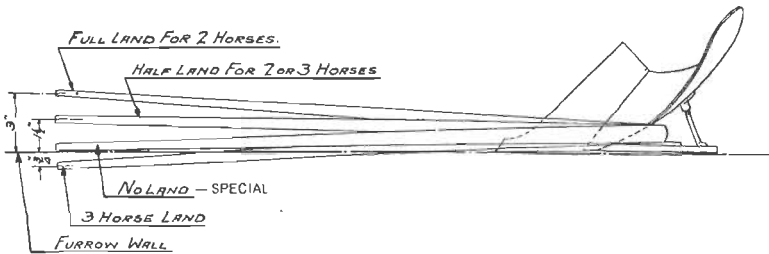


FIG. 154.—Illustrating how beams are landed for different size teams.

This tendency to plow too deep may be caused by too much suction; the vertical hitch of the clevis may be too high; or the beam may be bent upward. It is not often that a plow will have too much down suction, but if this does happen the remedy is a very simple one: decrease the amount of suction. If the hitch has been placed too high, this can be remedied by lowering the vertical hitch at the clevis; shortening the traces to bring the horses closer to the plow will also remedy this trouble. If the beam has been sprung or bent upward, as it may with steel beams, it is very difficult to bend the beam back to the original shape. The best remedy is to get a new beam.

181. Failure to Plow Deep Enough.—This trouble may be due to a number of causes, some of which are the reverse of deep plowing; such as, the hitch too low and the beam bent down. All these troubles are indicated by the operator having to lift up on the handles to make the plow penetrate the soil. If the hitch is too low this can be remedied by raising it at the clevis or lengthening the traces and moving the horses

away from the plow. If the beam is bent downward, the same remedy is used as in the case of the beam being bent upward. If the share has become dull, it should be taken off and sharpened. It may also need repointing. If the plow will not enter the ground because of its being too hard, the plow may be forced into the ground by adding weight.

182. Not Taking Enough Land.—When a plow fails to take the proper amount of land the following things may be wrong: too little horizontal suction; hitch too far to the left; too much wing bearing; beam sprung to the left; improper landing of beam (Fig. 154); landed too much in the rear; coulter may not be set properly. The remedy for all these causes is simple and indicated by the cause of the trouble.

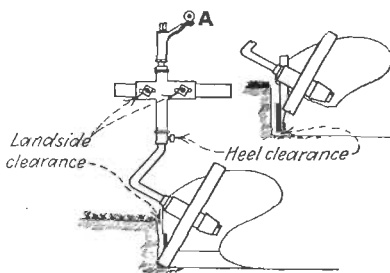


FIG. 155.—Method of adjusting landside and heel clearance.

183. Taking Too Much Land.

This trouble is just the reverse of the previous one, and the causes may also be just the opposite; such as, hitch too far to the right; too much horizontal suction; not enough wing bearing; beam bent toward the open furrow; jointer or coulter set improperly, leading toward the land. The remedies for these causes are obvious.

184. Failure to Scour.—Failure to scour is a very common trouble in the Southwest, in the blackland section, and in the close grain soils of the river bottoms. The plow is said to *scour* when the soil sheds clean from the moldboard. When non-scouring occurs, the soil will stick to the plow and will not shed off. Non-scouring may result from a number of causes:

1. The lack of an earth polish.
2. Improper plow adjustment.
3. Poor fitting of share and moldboard.
4. Cutting edge of share not level.
5. No suction.
6. Soil conditions not right.
7. Soft spots or irregularities in the moldboard.
8. Shape of bottom with relation to soil texture.
9. Speed.
10. Type of bottom not suited to soil.

The lack of polish may be caused by not having removed the special preparation placed on the plow by the manufacturer to prevent rusting until it reaches the hands of the plowman. This varnish-like covering should be removed with a varnish remover or lye. If lye is used, care should be taken that the surface is thoroughly washed and wiped dry after application. If this is not done, the surface is likely to be pitted.

Any plow that is made of metal that is not hard enough to withstand the scratching of the soil and will not take a good polish is always likely to give trouble. When plows are completed at the factory, the surface is finished by grinding. Grains left by the grinding process should run in the same direction that the furrow slice moves over the plow, or lengthwise of the moldboard. If this is done and the temper carefully made in the high-carbon steel, very little trouble is likely to be encountered by non-scouring in the average soil.

Improper adjustments causing non-scouring are the result of poor care of the plow. If the new share is placed on the plow and care not taken to place and fit it snugly to the moldboard so that they will be of the same level on the surface at the joint, it is likely to leave a place where there will not be enough pressure to prevent the soil from sticking.

A dull cutting edge and no suction can be remedied by sharpening and placing more suction in the share to make it penetrate and give pressure on the moldboard. It might be said just here in connection with the pressure of the furrow slice, that non-scouring can be remedied, to some extent, by increasing the pressure of the furrow slice upon the moldboard, as will be seen under the discussion of speed. The soil conditions may not always be just right for good scouring. The lack of a proper amount of moisture in the soil will sometimes cause non-scouring. Very little difficulty is ever encountered, however, in sandy and loamy soils. It is the clay and clinging soil that gives trouble. If the plow has not been hardened uniformly all over the surface, thereby leaving soft spots, the surface will wear away faster and cause dents where soil will hang and cling. Non-scouring may also be due to the use of improper plow shapes.

The lack of the proper speed will sometimes cause the plow not to scour. The plowman will often notice that if the speed is increased in the non-scouring part of the field, that the soil will shed much better. This is, of course, due to the pressure resulting from an increase of speed, practically forcing the soil off the surface of the moldboard. There are some conditions, however, under which high speed may cause failure to scour.

185. Methods Used to Aid Scouring.—Many interesting attempts have been made in the close fitting soils of the Southwest to provide a type of plow that will scour under almost all conditions. In some few instances farmers will be found who make a practice of using plaster of Paris on their plow moldboards. Of course, it must be replaced frequently, oftentimes once every day.

Other attempts have been made with special types of bottoms filled with holes through which water is allowed to flow. The best result obtained along this line is that of heating the moldboard by the use of

the exhaust from a tractor. A number of experiments run with an outfit equipped with pipes for heating the moldboard gave very good results. Those boards that were heated, shed the soil and scoured well. Moldboards that were on the same plow that were not heated would not scour. This is directly in line with the observations made by other plowmen who have noted that after the plow has stood in the sunshine and become heated, it plows better than after it has become cooled.

Recent experiments in England¹ show that when an electric current is passed through the soil having the moldboard as the negative electrode the soil would slip over the plow easier. It appears that the whole problem resolves into a soil problem and the effect of heat on soil colloids. Nichols² found that if the metal was hot, a decrease in the sliding friction was observed, but if the metal was cold and the soil was warm, the moisture films in contact with metal adhered to it.

186. Excessive Draft.—Some of the things discussed in the draft of plows that may give excessive draft in ordinary walking plows are: the hitch, the condition of the share, side draft, position and type of moldboard, set of the plow, and the condition and set of the coulters.

SULKY-PLOW TROUBLES AND ADJUSTMENTS

Since the sulky plow is a riding plow, the troubles encountered will be somewhat different. It is remembered that the plow is mounted on three wheels which support the weight of the plow bottom and at the same time influence the operation. Many of the troubles discussed under the walking plow are applicable to the sulky plow.

187. Draft of Sulky Plows.—The principal trouble of the sulky plow is that of the heavy draft, which may be caused from a combination of several troubles: dull shares, too much suction, too much landside friction. The remedy for dull shares is obvious. Too much vertical suction may result from the rear of the plow bottom being raised too high upon the rear furrow wheel shank or the rear of the beam elevated too much, as on the frame type of plow. Some authorities term this *heel clearance*³ (Fig. 155). The suction is given by elevating the rear of the plow. When new shares are placed on the plow, this may cause too much vertical suction, because the adjustment which has been made to suit the old worn share has not been changed.

188. Adjustment of Wheels.—Too much landside friction may be caused by the rear furrow wheel not being set far enough to the left of the landside and not having enough lead away from the furrow wall. In the adjustment of the sulky plow, both frame and frameless, the rear furrow

¹ *Jour. Agr. Sci., England*, Vol. XIV, Part II.

² *Am. Soc. Agr. Eng. Trans.*, Vol. XIX, pp. 173-185, 1925.

³ *U. S. Dept. Agr. Cir.*, 132, p. 42, 1930.

wheel is usually given a lead away from the furrow wall and gives *landside clearance* (Fig. 155). This throws the landside away from the furrow face and prevents friction which would result from sliding along in contact with the furrow face, as in the case of the walking plow. The front furrow wheel is given a lead toward the furrow wall; it is also inclined. This is done to hold the plow in its proper place and to overcome the side draft caused by the pressure of the furrow slice upon the moldboard. It is essential that all sulky plows be run with the frame level.

189. Scouring.—Scouring has been discussed under that of walking plows and will apply to the sulky plows.

GANG-PLOW TROUBLES

Since there is very little difference in the construction of the gang plow and that of the sulky, the same troubles will apply; however, there are one or two troubles that may be mentioned that are common only to gang plows.

190. Uneven Furrow Crown.—In an old gang plow that has become badly worn, the furrow crown may be left uneven; that is, some of the furrows may be left high and others low. This may be due to the front bottom cutting deeper than its mate or the front bottom cutting wider than its mate. These troubles may be the result of the frame being loose at the joint, or to the wearing at various points allowing considerable play of the plow in operation.

The wheels of gang plows will influence the operation of the plow and are handled slightly different from those on sulky plows. The rear wheel is given a lead, usually away from the furrow wall as in the case of the sulky. The front furrow wheel is given a lead away from the furrow wall because of the additional amount of side draft in the gang plow. The rear wheel is also set to the left of the line of the landside to give landside clearance.

TRACTOR-PLOW TROUBLES

There are many troubles encountered in tractor plows that do not develop in the smaller types of walking or gang plows. To get the tractor plow properly adjusted to the source of power, to eliminate all troubles, is a hard problem for the plowman.

191. Side Draft.—The problem of adjusting the tractor plow, for side draft, has been discussed under the heading of Hitches.

192. Failure to Penetrate.—Failure to penetrate may be the result of not having the proper amount of vertical suction. Vertical suction is given to the tractor plow by raising the rear of the frame. This is usually done by a setscrew on the axle of the rear furrow wheel (Fig. 156). By turning the setscrew down, the bottoms will be raised at the rear, putting

them up on the point. This has the same result as when the handles of a walking plow are raised.

193. Breaking the Furrow Wall.—This is caused by an extra amount of side draft, causing too much landside pressure on the furrow wall, and the improper setting of the coulters.

194. Excessive Draft.—Excessive draft may be due to some of the same causes as in the case of the gang plow, such as side draft, dull shares, and too much vertical suction.

195. Non-scouring.—Non-scouring is also a trouble encountered in engine gang plows and was discussed thoroughly under another heading. Some points may be brought up, however, affecting scouring directly, as in the gang plow. Should the plow have excessive side draft, this will have an influence upon the scouring quality. Adjustment of the hitch will overcome this, somewhat, provided the plow bottoms are the particular kind for the soil in which they are being operated. The setting of the coulter farther to the left or landward will influence scouring under some conditions. The tendency is to cut a wider furrow slice, causing more pressure upon the moldboard and thereby forcing the soil off clean. Moving it forward may also help. Again, the speed may be an influencing factor in the engine gang plow. Most moldboards have been designed to work at a speed of 2 to $2\frac{1}{2}$ miles per hour. If operated above this speed, they may fail to scour properly. Then again, if the power is overloaded, the speed may be reduced to such an extent that it will not be up to the point where scouring will be the best.

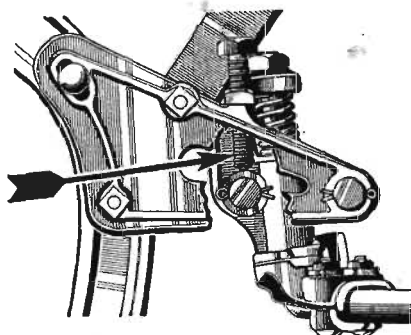


FIG. 156.—Setscrew to adjust vertical suction on engine gang plow.

DISK-PLOW TROUBLES

The troubles and adjustments of the disk plow are different from those of moldboard plows. Yet there are many troubles that are common to both classes.

196. Failure to Penetrate.—Failure to penetrate soil may be due to a lack of weight and the proper angle of the disk. The disk plow is weighted and partially forced into the ground. Therefore, if the frame is made rather light and the soil is hard, the plow may not penetrate easily. Provision is made on most disk plows for the placing of additional weight, especially on the rear wheel. Changing the angle of the disk to set nearer perpendicular will increase the tendency to penetrate.

TABLE IV.—ACRES PLOWED WITH HORSES PER 10-HOUR DAY

Location and item	Crew ¹	Rate, acres	Location and item	Crew ¹	Rate, acres
Central Illinois:			Minnesota—Marshall:		
Spring:			Spring wheat.....	1—4	3.46
24-inch gang.....	1—4	4.94	Corn.....	1—3	3.33
24-inch gang.....	1—5	4.64	Corn fodder.....	1—3	3.33
28-inch gang.....	1—4	4.84	Oats.....	1—4	3.46
28-inch gang.....	1—5	5.06	Barley.....	1—3	3.16
28-inch gang.....	1—6	5.31	Fall rye.....	1—4	3.33
Fall:			Old sod:		
24-inch gang.....	1—5	4.63	Flax.....	1—4	3.43
24-inch gang.....	1—4	4.33	Minnesota—Halstead:		
28-inch gang.....	1—5	4.80	Spring wheat.....	1—5	4.03
28-inch gang.....	1—6	4.96	Corn.....	1—5	4.05
Spring:			Corn fodder.....	1—4	3.83
14-inch sulky.....	1—3	2.91	Corn silage.....	1—5	3.13
16-inch sulky.....	1—3	2.97	Oats.....	1—4	4.02
16-inch sulky.....	1—4	3.29	Barley.....	1—4	3.77
Fall:			Fall rye.....	1—5	3.83
14-inch sulky.....	1—3	2.61	Flax.....	1—5	4.06
14-inch sulky.....	1—4	2.89	Minnesota—North River Valley:		
16-inch sulky.....	1—3	2.72	Potatoes.....	1—5	4.65
16-inch sulky.....	1—4	3.04	Montana—Gallatin Valley:		
16-inch sulky.....	1—5	3.37	Wheat.....	1—5	3.97
Pennsylvania—Chester County:			Western New York:		
14-inch walking.....	1—2	1.80	Sod:		
24-inch gang.....	1—4	3.60	10-inch walking.....	1—2	1.52
Corn Belt:			12-inch walking.....	1—2	1.53
8-inch walking.....	1—2	1.6	14-inch walking.....	1—2	1.54
10-inch walking.....	1—2	1.7	10-inch walking.....	1—3	1.76
11-inch walking.....	1—2	1.7	12-inch walking.....	1—3	1.81
12-inch walking.....	1—2	1.8	14-inch walking.....	1—3	1.85
14-inch walking.....	1—2	1.9	16-inch walking.....	1—3	1.97
16-inch walking.....	1—2	2.0	Stubble:		
8-inch walking.....	1—3	1.8	10-inch walking.....	1—2	1.72
10-inch walking.....	1—3	2.0	12-inch walking.....	1—2	1.71
11-inch walking.....	1—3	2.1	14-inch walking.....	1—2	1.79
12-inch walking.....	1—3	2.2	10-inch walking.....	1—3	1.89
14-inch walking.....	1—3	2.4	12-inch walking.....	1—3	1.92
16-inch walking.....	1—3	2.6	14-inch walking.....	1—3	2.00
12-inch sulky.....	1—2	1.7	16-inch walking.....	1—3	2.02
14-inch sulky.....	1—2	1.8	Sod:		
16-inch sulky.....	1—2	1.9	12-inch sulky.....	1—3	2.02
12-inch sulky.....	1—3	2.3	14-inch sulky.....	1—3	2.16
14-inch sulky.....	1—3	2.5	16-inch sulky.....	1—3	2.35
16-inch sulky.....	1—3	2.7	Stubble:		
12-inch sulky.....	1—4	2.4	12-inch sulky.....	1—3	2.19
14-inch sulky.....	1—4	2.6	14-inch sulky.....	1—3	2.28
16-inch sulky.....	1—4	2.9	16-inch sulky.....	1—3	2.46
24-inch gang.....	1—4	4.1	North Dakota:		
28-inch gang.....	1—4	4.4	28-inch gang.....	1—4	5.0
24-inch gang.....	1—5	4.6	28-inch gang.....	1—5	5.2
28-inch gang.....	1—5	4.9	28-inch gang.....	1—6	5.5
24-inch gang.....	1—6	4.9	Georgia:		
28-inch gang.....	1—6	5.4	Laurens County (cotton).....	1—1.8	1.6
Idaho:			Greene County (cotton).....	1—1.7	1.5
In orchard:			Sumter County (cotton).....	1—1.9	2.0
12-inch.....	1—2	1.38	Alabama:		
Western Colorado:			Tallapoosa County (cotton)....	1—1.2	1.2
In orchard.....	1—2	1.44	Marshall County (cotton).....	1—1.7	1.6
Louisiana:			Dale County (cotton).....	1—1.7	1.6
Sod, flat breaking:			South Carolina:		
10-inch walking.....	1—2	1.65	Anderson County (cotton).....	1—1.8	1.8
12-inch walking.....	1—2	2.11	Barnwell County (cotton).....	1—1.4	1.6
Minnesota:			Texas:		
Fall plowed:			Ellis County (cotton).....	1—3.3	2.1
Spring wheat.....	1—3	2.70	Rusk County (cotton).....	1—1.9	2.0
Spring plowed:			Utah:		
Corn.....	1—3	2.74	Irrigated:		
Corn fodder.....	1—3	2.71	Potato and sugar beets.....	1—2	2.78
Corn silage.....	1—3	2.70	West Virginia:		
Oats.....	1—3	2.75	Wheat.....	1—2	1.33
Barley.....	1—3	2.75	Corn.....	1—2	1.43
Fall plowed:			Washington—Wenatchee:		
Hemp.....	1—3	3.20	Orchard:		
Old sod:			12-inch.....	1—2	1.49
Flax.....	1—3	2.79	Washington—Yakima:		
			Orchard.....	1—2	1.58

¹ First figure refers to number of men and second figure to number of horses in crew.
U. S. Dept. Agr. Yearbook, p. 1046, 1922.

197. Width of Cut.—It is often necessary to change the adjustments on a disk plow as the hardness of the soil varies. With a soft soil a wide furrow is desirable, but with a hard soil a narrow furrow is essential. Moving the beam on the front furrow-wheel axle will influence the cut, as will changing the position of hitch and lead of the furrow wheels.

TABLE V.—ACRES PLOWED WITH TRACTORS PER 10-HOUR DAY

Location, size, and type	Size of plow	Depth, inches	Rate, acres	Location, size, and type	Size of plow	Depth, inches	Rate, acres
South:	Inches			Northwestern United States—Continued.	Inches		
2-bottom disc.....	.....	8.75 ¹	4.7	30 horsepower, plow....	113.0	.....	18.2
2-bottom moldboard.....	.....	.....	5.3	20 horsepower, break....	59.0	.....	10.6
3-bottom disc.....	.....	.....	6.5	20 horsepower, plow....	84.0	.....	13.8
3-bottom moldboard.....	.....	.....	7.3	General United States:			
Corn Belt:				Stubble, 6-7 inches deep:	Feet		
2-plow (spring).....	.....	.....	6.6	15 horsepower.....	7.4	.....	14.0
2-plow (fall).....	.....	.....	6.5	20 horsepower.....	7.9	.....	16.7
3-plow (spring).....	.....	.....	8.6	22 horsepower.....	9.7	.....	19.1
3-plow (fall).....	.....	.....	8.6	25 horsepower.....	11.3	.....	20.6
Illinois:				30 horsepower.....	11.5	.....	22.5
2-plow.....	.....	.....	6.5	32 horsepower.....	14.6	.....	29.6
3-plow.....	.....	.....	8.7	40 horsepower.....	15.3	.....	30.4
2-plow (spring).....	.....	.....	7.0	45 horsepower.....	10.0	.....	20.0
2-plow (fall).....	.....	.....	6.4	60 horsepower.....	12.3	.....	24.8
3-plow (spring).....	.....	.....	8.7	Sod, depth 4.2-4.7 inches:			
3-plow (fall).....	.....	.....	8.1	15 horsepower.....	5.2	.....	9.1
North Dakota:				20 horsepower.....	6.1	.....	11.9
15 horsepower, gasoline... 77.1	5.9	14.0		22 horsepower.....	7.9	.....	13.9
15 horsepower, kerosene... 80.6	6.2	15.0		25 horsepower.....	9.8	.....	16.2
30 horsepower, gas..... 110.8	6.1	21.0		30 horsepower.....	9.7	.....	17.9
30 horsepower, kerosene... 123.3	6.3	23.0		32 horsepower.....	13.0	.....	23.9
Illinois:				40 horsepower.....	13.8	.....	24.9
2-plow.....	.....	.....	6.5	45 horsepower.....	8.4	.....	15.2
3-plow.....	.....	.....	8.8	60 horsepower.....	9.3	.....	15.9
4-plow.....	.....	.....	10.0	Central Illinois:	Inches		
Illinois—Corn Belt:				2-plow (spring).....	28.0	.....	6.9
2-plow.....	.....	.....	6.7	3-plow (spring).....	42.0	.....	8.5
3-plow.....	.....	.....	8.2	2-plow (fall).....	28.0	.....	6.3
4-plow.....	.....	.....	10.4	3-plow (fall).....	42.0	.....	7.9
5-plow.....	.....	.....	12.6	Minnesota:			
6-plow.....	.....	.....	15.3	Clay County.....	.....	.....	11.4
8-plow.....	.....	.....	20.2	Anoka County, 3-plow..	.....	.....	6.5
10-plow.....	.....	.....	23.0	Wisconsin:			
North Dakota:				Barron County, 3-plow.	.....	.....	9.0
2-plow.....	.....	.....	6.3	Waupaca County, 2-plow.....	.....	.....	7.0
3-plow.....	.....	.....	8.5	Michigan:			
4-plow.....	.....	.....	10.9	2-plow.....	.....	.....	6.0
New York:				New York—Monroe County:			
2-plow.....	.....	.....	4.5	2-plow.....	.....	.....	3.0
3-plow.....	.....	.....	6.3	Maine—Aroostook County:			
Northwestern United States:				2-plow.....	.....	.....	5.2
22 horsepower, break..... 78.0	.....	15.1					
22 horsepower, plow..... 122.0	.....	22.6					
30 horsepower, break..... 78.0	.....	13.2					

¹ Average depth for region.

U. S. Dept. Agr. Yearbook, p. 1047, 1922.

Under most conditions, the front furrow wheels should run straight forward, parallel to the line of the furrow. If the plowing is exceptionally hard, it may be given a slight lead to the furrow wall. Usually, the wheels are given a lead toward the plowed ground to counteract the side pressure of the furrow slices. Since disk plows do not have land-sides, the wheels must hold the plow in position.

Should there be a tendency of the bottoms to trail, it may be due to the hitch being too far to the right. This arrangement of the hitch will have a tendency for each of the bottoms to cut a narrow furrow width due to their trailing behind one another.

Disk plows do not always cover trash as well as do moldboards. This is especially true when they are operated without scrapers. If the disk is set rather flat from the vertical, it will not cover trash as well as when set more nearly straight up and down. When set straight up and down, the furrow slice will be thrown over more abruptly to the side. If the scraper is in use, the furrow slice will be taken from the disk and turned.

TABLE VI.—AVERAGE DEPTH OF PLOWING IN THE VARIOUS STATES¹

State	Fall, inches	Spring, inches	State	Fall, inches	Spring, inches
Maine.....	7.5	7.6	North Dakota.....	5.0	4.7
New Hampshire.....	7.0	6.9	South Dakota.....	5.1	5.2
Vermont.....	6.5	6.3	Nebraska.....	5.2	5.4
Massachusetts.....	7.4	7.8	Kansas.....	4.8	5.0
Rhode Island.....	6.0	6.3	Kentucky.....	5.9	6.0
Connecticut.....	6.5	6.4	Tennessee.....	6.0	5.6
New York.....	6.4	6.4	Alabama.....	5.3	4.2
New Jersey.....	6.4	6.9	Mississippi.....	4.0	3.3
Pennsylvania.....	6.7	6.5	Louisiana.....	5.0	4.3
Delaware.....	5.9	6.3	Texas.....	4.9	4.2
Maryland.....	6.3	6.5	Oklahoma.....	4.5	4.5
Virginia.....	6.6	6.5	Arkansas.....	5.0	4.4
West Virginia.....	6.1	6.0	Montana.....	5.5	5.5
North Carolina.....	6.5	5.8	Wyoming.....	5.9	5.6
South Carolina.....	5.8	4.9	Colorado.....	5.7	6.1
Georgia.....	5.1	4.0	New Mexico.....	5.6	5.2
Florida.....	5.7	4.7	Arizona.....	5.8	5.8
Ohio.....	6.4	6.9	Utah.....	7.5	6.7
Indiana.....	6.0	6.5	Nevada.....	6.6	6.7
Illinois.....	5.7	5.3	Idaho.....	6.1	6.1
Michigan.....	6.7	6.4	Washington.....	6.4	6.4
Wisconsin.....	6.0	5.7	Oregon.....	6.0	6.1
Minnesota.....	5.4	5.0	California.....	6.1	6.5
Iowa.....	5.7	5.0			
Missouri.....	5.6	5.6	United States....	5.45	5.12

¹ U. S. Dept. Agr. Yearbook, p. 700, 1918.

The scraper having a curved surface will turn the furrow slice better than the straight type; however, the straight type will shed soil better and give less trouble when sticky soils are being plowed. As a general rule, the scraper should be set low and at an angle of about 35 degrees with the disk. It is also tilted to throw the soil toward the furrow.

198. Duty of Plows.—There is considerable difference in the amount of work that can be accomplished with different types of plows. Tables IV and V show the average number of acres plowed per 10-hour day with horses and tractors, for the different sections of the United States.

199. Depth of Plowing.—The average depth of plowing for the various states is shown in Table VI.

200. Life of Plows.—According to studies made in Minnesota¹ the average annual depreciation of walking plows is 5.8 per cent, sulky plows 8.34 per cent, and gang plows 6.41 per cent.

Data collected in Iowa by Wallace² shows the average life of plows for that section: walking and sulky plows 10 years, gang plows 7.76 years. The greatest item of expense was for new shares.

201. Cost of Plowing.—Jensen³ figures the cost of plowing an acre with a two-horse walking plow as follows: Acres plowed per day, 1.8. Man-hours per acre, 5.55. Man labor cost, \$0.83 per acre. Mule-hours per acre, 11.0. Cost of mule labor per acre, \$1.28. Total cost per acre, \$2.11.

A man-hour was figured to be worth \$0.27 while a horse-hour was worth \$0.17. At this rate, horse plowing cost \$2.63 per acre. When \$0.85 was figured for a tractor-hour, the total cost of plowing an acre was \$1.37. Of course, the unit allowed for man, horse, and tractor hours will vary with the sections and conditions.

TABLE VII.—COMPARISON OF REQUIREMENTS PER ACRE OF HORSE AND TRACTOR PLOWING¹

	Hours per acre with man and horse		Hours per acre with man and tractor	
	Man hours	Horse hours	Man hours	Tractor hours
Plowing.....	2.7	11.2	1.3	1.2

¹ U. S. Dept. Agr. Bull. 1198, p. 9, 1924.

In some of the middle western states, where four- and five-bottom plows are used, farm-power contractors, in 1936, charged from \$1.10 to

¹ Minn. Agr. Expt. Sta. Bull. 59.

² Am. Soc. Agr. Eng. Trans., Vol. XIX, p. 139, 1925.

³ S. C. Agr. Expt. Sta. Bull. 221, p. 26, 1924.

\$1.25 per acre for plowing under average conditions. For unusually heavy land and small fields the charge ran as high as \$1.77 per acre.

LAYING OUT FIELDS FOR PLOWING

Before starting to plow a field much time can be saved if the field is first staked out in uniform width lands. Methods that leave dead furrows running down the slope should be avoided, as water may collect in

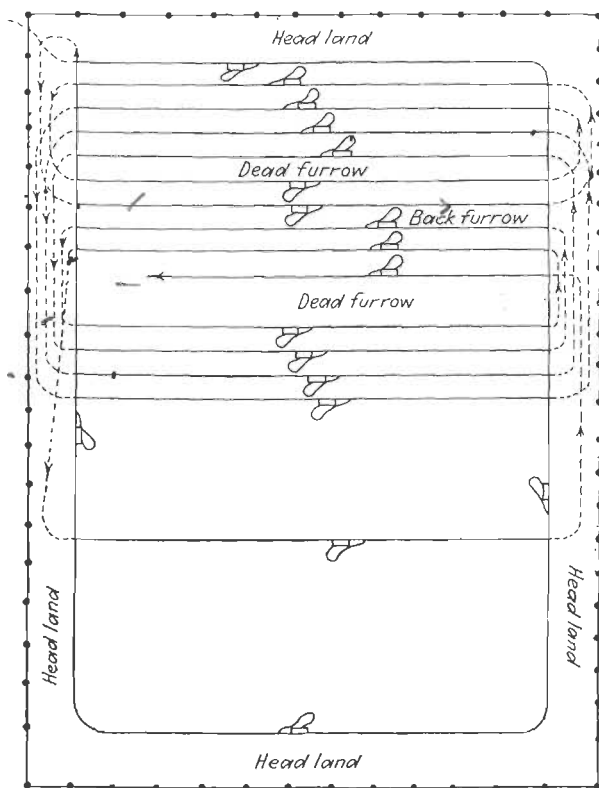


FIG. 157.—Method of laying out field for plowing.

them and cause serious erosion. The method of starting at the sides and plowing around and around to finish in the center of the field will, if practiced year after year, create low areas at the dead furrows.

202. Plowing Level Unterraced Fields.—If the field is comparatively level, it can be advantageously plowed in lands. First, headlands approximately twice the length of the tractor and plow should be staked off on all sides. Mark out the headland by plowing shallow once around the field, as indicated in Fig. 157, leaving the corners round to aid in plowing the headland at the finish. Stake out the lands in uniform widths. A multiple of the width of the capacity of the plow should be used. A good

device for measuring lands is the A frame shown in Fig. 158. Plow the first furrows through the middle of the second land, then back on the outside of the first land. Continue this procedure until turning is difficult without making a figure-of-eight turn, then swing over and open up another land and finish the first land on the return trips (Fig. 157). When all the lands have been plowed, the head-land is plowed by either throwing the furrows toward or away from the outside.

203. Plowing Terraced Fields.—Areas between terraces are irregular in width and the most simple but undesirable method is to plow the whole area between two terraces as one land. This method leaves a dead furrow midway between terraces and often results in serious erosion. The most logical way of plowing terraced land is to use a two-way plow. Begin on the down-hill side of the terrace, throw all furrows up hill, and continue back and forth until the channel of the next terrace down hill is reached. This method will leave the dead furrow in the channel and aid in clearing it of accumulations of silt. The method also aids in counteracting the down-hill movement of the soil.

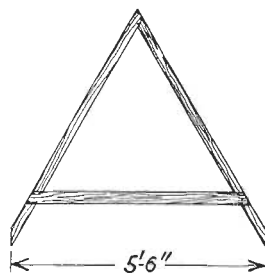


FIG. 158.—An A frame for measuring fields in place of stepping off.

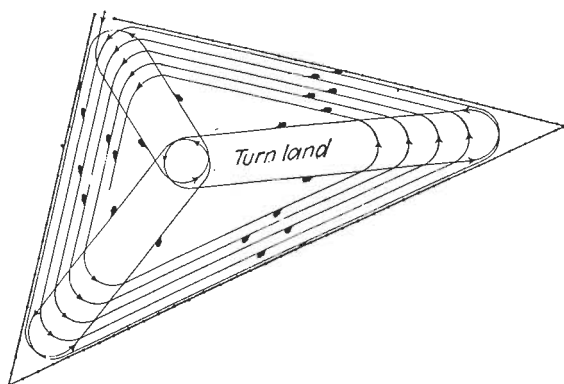


FIG. 159.—Method of plowing a triangular field.

204. Plowing Triangular and Irregular-shaped Fields.—The simplest method of plowing triangular- or irregular-shaped fields is to bisect the angles, leaving a strip of equal width on each side of the line unplowed so that all turning can be done on firm soil (Fig. 159). This method will, if practiced, cause the development of deep dead furrows. The use of two-way plows on irregular-shaped fields will leave no dead furrows extending inward from the corners.

PART IV

SEED-BED PREPARATION MACHINERY

CHAPTER XV

STALK CUTTERS, HARROWS, LAND ROLLERS, AND DRAGS

The action of the plow on the soil does not prepare an ideal seed bed. Unless the soil is very sandy, loose, and mellow, it needs further pulverizing by the use of tools specially prepared for the purpose. These tools are used principally in the preparation of the plowed ground for the

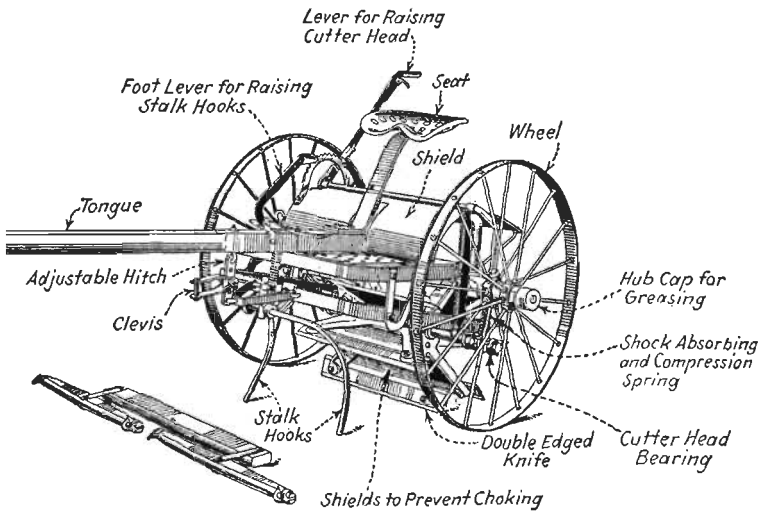


FIG. 160.—Single-row stalk cutter.

seed. Some of them are used before plowing, however, others may be used later to cultivate the growing plants.

STALK CUTTERS

205. Machinery for Cutting Stalks.—If the crop grown produces large stalks, such as cotton and corn, it is necessary to cut them into short pieces before the ground can be plowed and vegetable matter buried.

Figure 160 shows an ordinary single-row stalk cutter. It is also built in a two-row unit which has two cutting heads. It is this type that is most generally used on corn and cotton stalks.

The cutting head consists of two spider castings to which are bolted knives. Both sides of the knives are sharpened so they can be reversed when one side becomes dull. Usually provision is made to prevent the knives shearing the bolts that hold them on. This may be either a shoulder for the knives to rest against or a projection of the casting through the knife at the bolt hole.

Some cutters are built to prevent the cutting head from clogging with stalks. Strips of sheet steel (Fig. 160) extending from the knife to the axle keep the pieces of stalks from collecting in the center of the cutting head where they may form a large ball, completely choking the machine. Many farmers clean the head by burning, however, this practice is not advocated.

Stalk hooks are necessary to pull the stalks parallel to the row so that the knives can cut them.

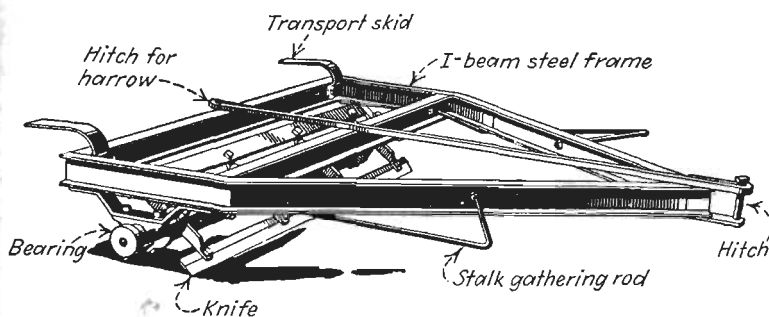


FIG. 161.—Two-row tractor rolling stalk cutter.

When in operation, the entire weight of the machine and operator is placed upon the knives to force them into the soil and cut the stalks. To prevent rigidity and roughness of riding, pressure or shock-absorbing springs are provided (Fig. 160).

Other methods of disposing of stalks are:

1. Drag them down with a heavy weight, such as a railroad rail and run over them with a tandem disk harrow.
2. Where cotton stalks are large, especially constructed, well-sharpened, angle-iron cleats used on the rear wheels of a tractor will cut up the stalks satisfactorily.
3. Homemade stalk cutters do excellent work in cutting up stalks. A good stalk cutter can be made by attaching long knives to a cast-iron or wood drum.¹

206. Tractor-drawn Stalk Cutter.—A two-row tractor-drawn rolling stalk cutter is shown in Fig. 161. The four knives are made of tough steel and are bolted to four forged-steel spiders. The cutting width of a single head is 76 inches. Special hitches can be secured for a four- and six-row hookup. The bar on top and in the center of the frame provides a means of hitching a harrow behind the cutter.

¹ *Tex. Agr. Expt. Sta. Bull.* 362, p. 9, 1927.

For transporting, the machine is ended over on the transport skids. A homemade tractor-drawn stalk cutter is shown in Fig. 162.

HARROWS

The harrow is an implement used to level the ground and crush the clods, to stir the soil, prevent and eradicate weeds, and to cover seed.

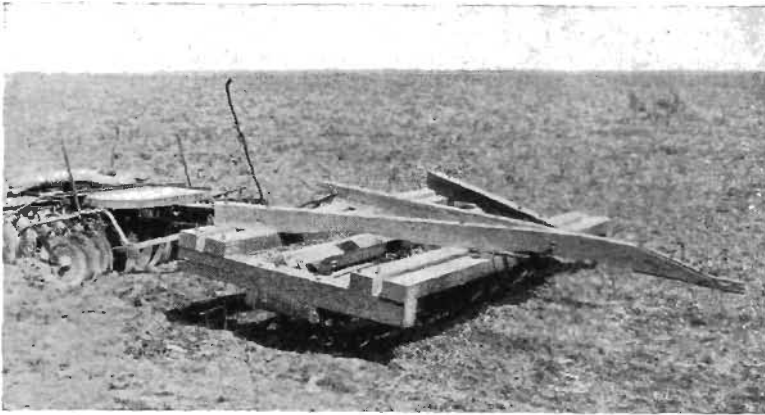


FIG. 162.—Homemade tractor stalk cutter. (Photo by Bentley.)

There are four principal kinds of harrows; namely, the spike-tooth, the spring-tooth, the disk, and the acme.

207. Spike-tooth Harrows.—Spike-tooth harrows, as shown in Fig. 163, are so-called because the teeth resemble long spikes. This harrow

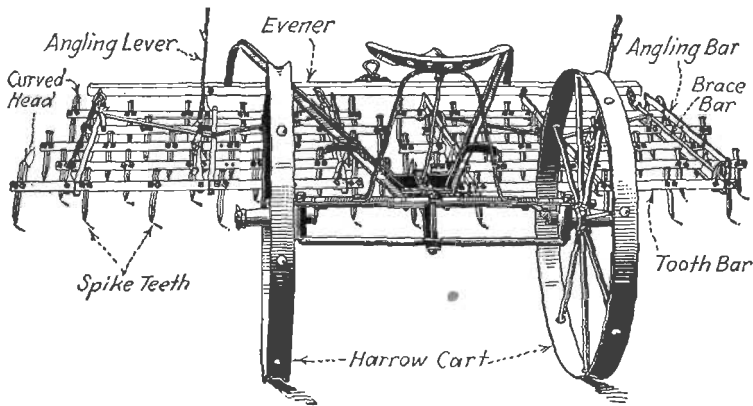


FIG. 163.—Rigid spike-tooth harrow equipped with harrow cart.

is also known as a *peg-tooth harrow*, a *drag harrow*, a *section harrow*, or a *smoothing harrow*. The principal use of the spike-tooth harrow is to smooth and level up the soil directly after plowing. It will stir the soil to a depth of about 2 inches if weighted, but, as a general rule, it is not considered a very good clod crusher unless the soil is rather mellow. This

type of harrow is used in the cultivation of corn and cotton and other crops for the first time; it saves much time and labor. Spike-tooth harrows are made in sections. Each section may be 4 to 5 feet wide and have 25, 30, or 35 teeth. Several sections can be used together, depending on the power available.

The harrow is made up of a number of teeth attached to bars, which may be of steel or wood. If made of steel, they are usually U-shaped steel bars. The teeth are then placed across the face of this U and held firmly against the edges by means of clamps, which may take a number of forms, two of which are shown in Fig. 164. The ends of these bars are often protected by a guard rail (Fig. 165) which is a strap of steel placed along the end of the bars to prevent

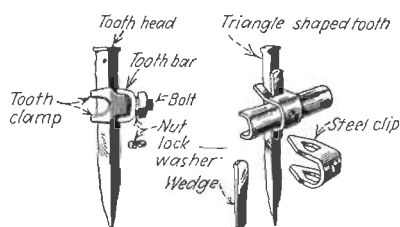


FIG. 164.—Types of clamps for diamond- and triangular-shaped teeth on spike-tooth harrows.

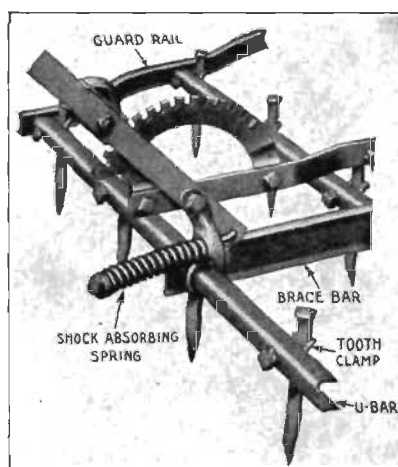


FIG. 165.—Part of a section of a spike-tooth harrow showing guard rails and shock-absorbing spring.

them from hanging on any obstruction, such as stumps, gates, and fences. When guard rails are used, the harrow is called a *closed-end* type. Harrows without guard rails are *open-end* types.

The teeth may be made in several different shapes, such as round, oval, square, triangular, or diamond. The diamond-shaped tooth (Fig. 164) seems to be the most popular, because of the fact that it may be reversed and present a new cutting edge when one side of the tooth has become dull. The sharp corner of the tooth also aids in holding it firmly against the bar. All teeth should be provided with heads to prevent losing them if the clamps become loose.

At each corner of the section there is a tooth with a head that is long and curved in such a manner that when the teeth are placed flat, these teeth will serve as runners (Fig. 163). The points of the teeth during transportation from one field to another are not dragged over the roads and worn.

The teeth should have a wide range of adjustment varying from a horizontal to a vertical position. Any angle desired can be had by means of levers provided for the purpose.

208. Rigid and Flexible Harrows.—Spike-tooth harrows are made either rigid or flexible. They are rigid when the steel bars have a brace across them at right angles to the teeth bars, as shown in Fig. 163. There is no means of adjustment other than that of adjusting the angle of the

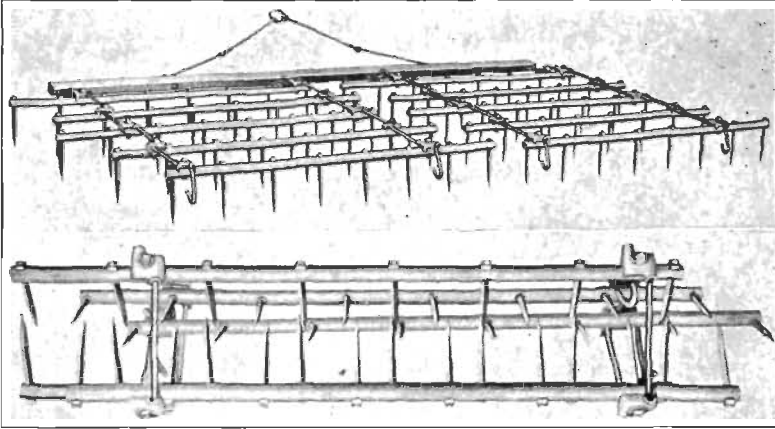


FIG. 166.—Flexible spike-tooth harrow.

teeth. A flexible harrow (Fig. 166) may be rolled up as the links between each tooth bar are hinged. This also allows the harrow to adjust itself to uneven ground much better. Such harrows are provided with draft hooks on both sides. The angle of the teeth cannot be changed.

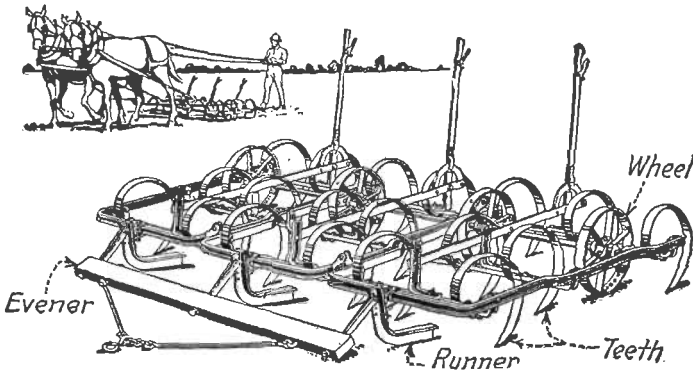


FIG. 167.—Spring-tooth harrow.

209. Riding Attachments.—A special attachment called a *harrow cart*, shown in Fig. 163, can be secured to fit any spike-tooth harrow. Harrow carts consist of two wheels, axle, and seat, which is connected to the eveners in front of the sections by long bars. If the harrow cart is not used, the operator may ride by standing on a board placed across two sections.

210. Horse-drawn Spring-tooth Harrow.—The spring-tooth harrow, as shown in Fig. 167, is made up somewhat on the same general plan as that of the spike-tooth harrow. Spring-tooth harrows are adapted for use in rough and stony ground. The teeth will penetrate deeper than those on

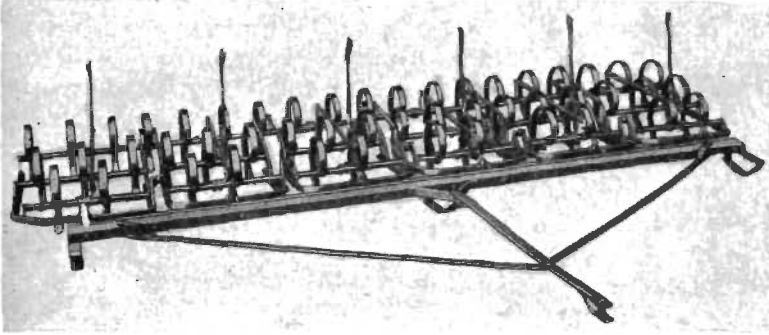


FIG. 168.—Six-section tractor spring-tooth harrow.

spike-tooth harrows, and they will give when obstructions are struck. It is frequently advertised as a quack-grass and Bermuda-grass eradicator since the teeth penetrate deeply, tear out, and bring the roots to the surface. Alfalfa sod is also cultivated with spring-tooth harrows. The teeth in the spring-tooth harrow consist of wide, flat, curved, oil-tempered

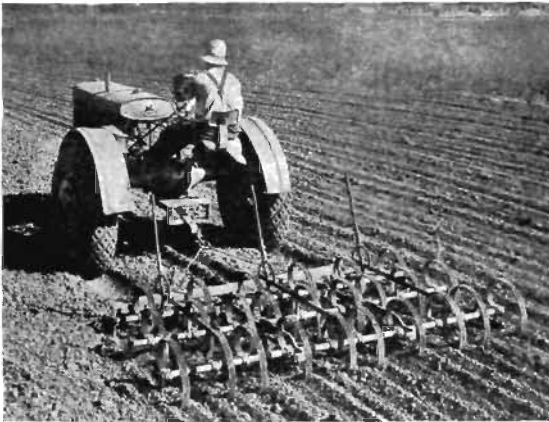


FIG. 169.—Spring-tooth harrow drawn by general purpose tractor.

bars of spring steel, one end of which is fastened rigidly to a bar; the other end is pointed to give good penetration (Fig. 170). The depth to which the teeth will penetrate the soil is controlled by adjusting the angle of the teeth by means of levers as in the case of the spike-tooth harrow. This is also supplemented by the weight of the harrow. Wheels or runners are provided as a means for transportation.

Figure 168 shows a six-section tractor-drawn spring-toothed harrow equipped with tractor hitch.

211. Special Harrow Teeth.—Some spring-tooth harrows are made with teeth having detachable points (Fig. 170). Points of various widths can be obtained according to the purpose and type of work to be done.



FIG. 170.—Types of teeth used on spring-tooth harrows: *A*, regular; *B*, quack grass; *C*, alfalfa, *D*, detachable point.

For harrowing recently broken ground, the wide tooth is better. Since this harrow makes a splendid cultivator for alfalfa, the narrow, sharp point is the best to use for cultivating this crop. The narrow point will penetrate deeply into the soil slipping around the crowns of the roots and not cutting them off as would the wide point.

212. Special Orchard Harrows.—In the last few years a special type of spring-tooth harrow (Fig. 171) has been introduced, which is adaptable principally for use with tractors. Such machines have proved valuable in the preparation of seed beds, stubble land, summer fallowing, and for destroying thistles. They have become quite popular in the Northwest. This tool is designed in independent sections which are under spring

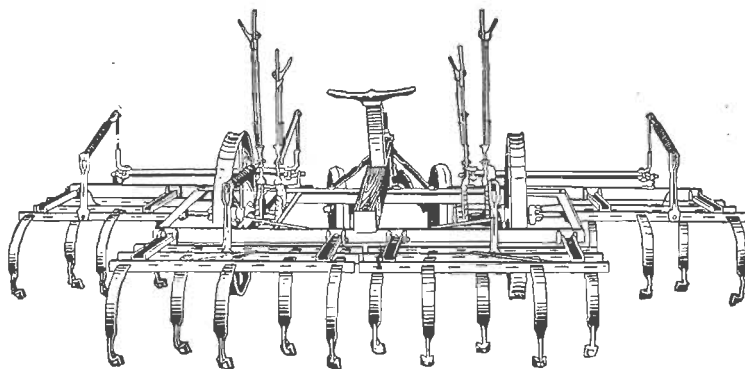


FIG. 171.—Spring-tooth orchard harrow.

tension, lever controlled, making it possible to regulate uniformly the depth of penetration in the soil. Each section is equipped with heavy tempered, spring-steel teeth, which have a high throat for clearing heavy trash. It is made of heavy material throughout.

Figure 172 shows a rigid-tooth type of orchard harrow; the main frame is made of heavy angle steel well braced. The harrow is carried on wide-tired steel wheels. This type of harrow is adaptable for use in extremely hard soils, for subsoiling, and in the preparation of seed beds.

213. The Acme Harrows.—This type of harrow is sometimes called a knife harrow, since the cutting blades consist of large knives. These knives may be either straight or curved. The acme harrow consists of a series of knives attached securely to a frame. The straight knives are so called because the cutting edge is straight, giving a slicing action.

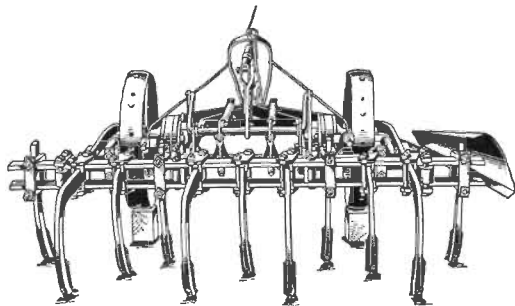


FIG. 172.—Orchard harrow equipped with power lift.

The curved knife (Fig. 173) is given a couple of curves and has a tendency to turn the soil more than once. It makes an excellent clod crusher, and a good soil mulch. It is also good for orchards and sod land, which have recently been plowed. It is very effective in leveling the soil. The harrow is constructed in sizes suitable for one or four horses and for tractors. Provision is made for the operator to ride. Some of the smaller types, however, do not have riding facilities. The weight of the harrow may be

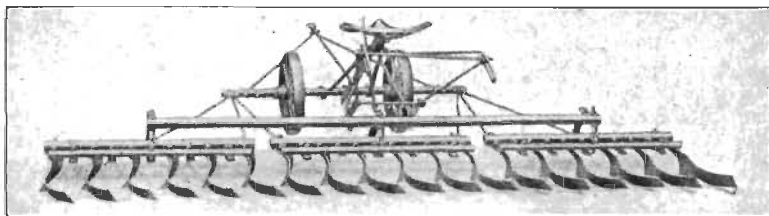


FIG. 173.—Acme harrow equipped with cart and three sections of curved knives.

supported by the knives or the front part of the harrow may be supported by a truck.

214. Disk Harrows.—Next to the plow, the disk harrow is the most valuable tool employed on the farm to prepare the seed bed.

The many uses of the disk harrow are enumerated as follows:

1. It is used before plowing to cut up vegetable matter that may be on the surface, such as cornstalks, cotton stalks, and weeds, and pulverize the top of the soil to such an extent that the furrow slices will make better connection with the bottom of the furrow soles, preventing air spaces when slices are turned.
2. It is used after plowing to pulverize the soil and put it in better tilth for the reception of the seed. Oftentimes land plowed in the fall will need diking in the

spring. This will save replowing and put the soil in the best possible condition for spring seeding.

3. It puts all plowed ground in condition for spring planting.
4. It is used for the cultivation of crops.
5. It is used for summer fallowing.
6. When seed are sown broadcast, it is used to cover them.

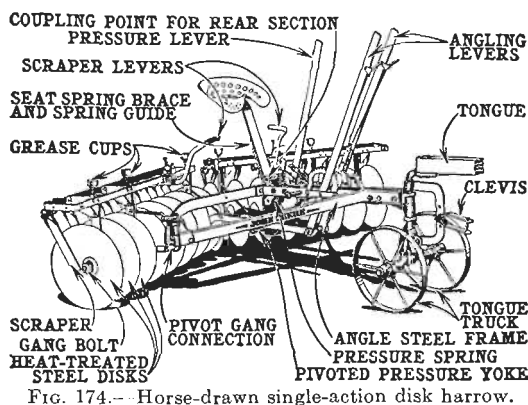


FIG. 174.—Horse-drawn single-action disk harrow.

There are many different types of disk harrows designed to suit different conditions but they all may be divided into two classes: single and double action.

215. Single-action Disk Harrows.—Single-action disk harrows consist of two gangs placed opposite each other, both gangs being set to throw the soil in the opposite direction from the other (Fig. 174).

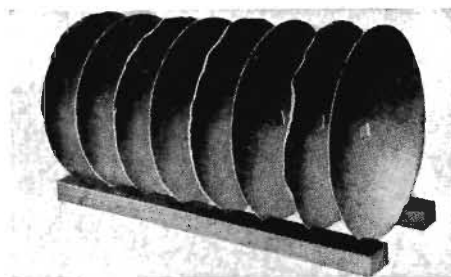


FIG. 175.—Each alternate disk has been heat treated. Note the smooth edges of the treated disk.

216. Disks.—Round smooth-edged heat-treated disks are used on all standard disk harrows. A few special harrows are equipped with either *cutaway* or *spading* disks. Disk blades for harrows range from 14 to 22 inches in diameter. The 16- to 20-inch sizes are popular for horse-drawn harrows, and the 18- to 22-inch sizes are common on tractor harrows.

Disks for harrows are made of high-grade steel and are heat treated. The hard heat-treated disks do not crimp up (Fig. 175) and do not require frequent sharpening.

217. Disk Gangs.—Disk gangs consist of a number of *disks* spaced about 6 inches apart on a *gang bolt* or *arbor bolt* which holds all the disks rigidly together (Fig. 174). The number of disks on a gang may vary anywhere from three to ten. The disks are held an equal distance apart by a *spool* (Fig. 176). The gang bolt is a square bolt and makes all the disks turn together as a unit. These bolts have a head on one end and a nut on the other. The nut should have some means of locking it on so that it will not turn off and be lost. If the disks become loose, they will wobble and poor work will be the result.

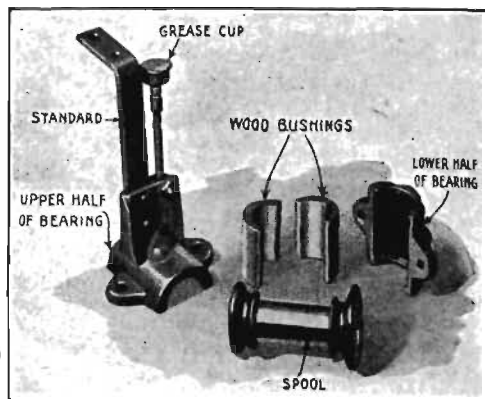


FIG. 176.—Bearing assembly for disk harrow.

218. The Harrow Frame.—The frame of disk harrows is made strong by the use of angle steel. It is well braced and absolutely rigid. Rigidity is necessary in order that a certain amount of the end thrust can be taken care of in the frame. The majority of harrows have the frame placed overhead the disk. Some few place the frame to the front, however, lowering it to the level of the center of the disk. The former method is better because of the extra amount of clearance. The frame is attached to the gang by means of the *standard* (Fig. 176) which extends from the frame downward to the bearing on the gang bolt.

219. Bearings.—There may be two to three bearings on each individual gang. These bearings consist of a specially designed spool around which is bolted a malleable-iron casting which provides a place to attach the standard, also a place for attaching the frame and for angling the gang (Fig. 176). In between the malleable-iron casting and the spool is placed a *bushing* made of wood or chilled iron (Fig. 176). The wood bushing has been hardened by boiling in oil. It is used as a bearing

because of the large amounts of dust and grit that come in contact with it in spite of the efforts of the manufacturers to make this bearing dust proof. It is surprising how well these wooden bearings will last. When worn, they can be replaced with only a few cents cost. Some of the large tractor-drawn double harrows, and one or two single harrows, have chilled-iron bearings, eliminating the wooden bushing (Fig. 177).

220. Lubrication.—Harrow bearings are lubricated by means of grease cups and pressure fittings. The cups or fittings are placed on the ends of pipes which may extend up above the frame. Some harrows have the grease cups screwed directly into the bearings, thus eliminating the pipe altogether. Most harrows are lubricated by having holes in the top of the bearing cap into which the pipe, cup, or pressure fitting is screwed, and through which grease is forced into the bearings. The construction of the disk harrow throws the weight of the frame upon the top of the bearing tending to close the outlet of the grease tube, thus making it very difficult to force the grease into the bearings. One or two manufacturers have made a decided step forward in the lubrication of harrow bearings. The grease cup is screwed directly into the bearing and the grease is forced through a hollow part of the bearing to the bottom side where it can enter freely between the bearing cap and the spool.

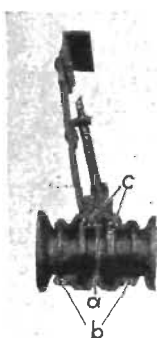


FIG. 177.—
Chilled-iron bearing for disk harrow equipped with pressure oil fitting.

221. Bumpers.—When operating, disk harrows have the gangs set at an angle, which causes a decided pressure to the center. All this cannot be taken care of by the bearings. Bumpers are placed on the inner ends of the gangs which are allowed to come in contact with each other or bump together. The bumper is a large cast-iron casting placed on the outside of the last disk to take care of the wear which will result when the gangs bump together.

222. Scrapers.—Scrapers (Fig. 174) are placed on the disk harrow to clean the disks and may be of two types: stationary and oscillating. If stationary, they are bolted rigidly and can be adjusted only a very slight amount by means of slotted holes. The oscillating type is held against the disk by springs. Extending out to the front is a foot lever which is attached to the scraper bolt. A downward pressure on the lever will move the scraper from the center of the disk out to the edge, thus cleaning the whole disk as it revolves.

223. Weight Boxes.—Weight boxes or pans (Fig. 178) are provided on disk harrows so that additional weight can be placed on the harrow, if penetration cannot be secured otherwise. These boxes may consist of a solid pan, or a skeleton-like box. Ordinarily, the weight pans are

placed on the frame directly above the gangs. They provide a means for placing stones or sacks of earth on the harrow, adding weight to force it deeper into the soil. A special weight attachment is shown in Fig. 179.

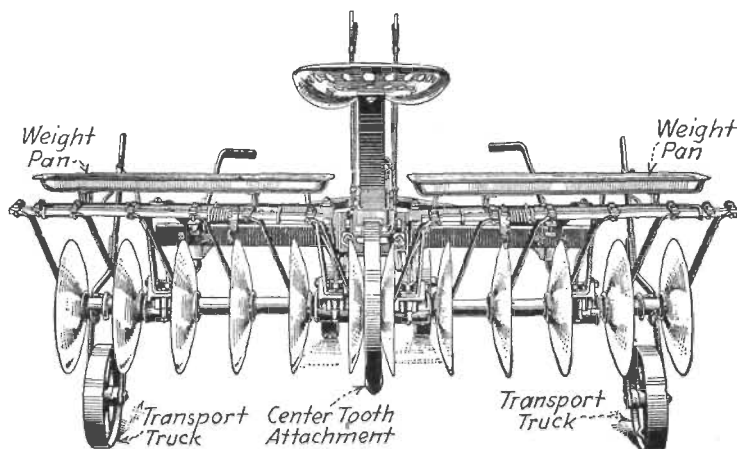


FIG. 178.—Single-disk harrow equipped with weight pans, transport trucks, and center-tooth attachment.

224. Center-depth Regulator.—When the gangs in single-disk harrows are set to throw the soil from the center, there is always a tendency for the center end to penetrate a less depth than the outer end. By means of a depth regulator additional pressure can be brought to bear on the inner end of the gang, forcing that end deeper into the soil and giving

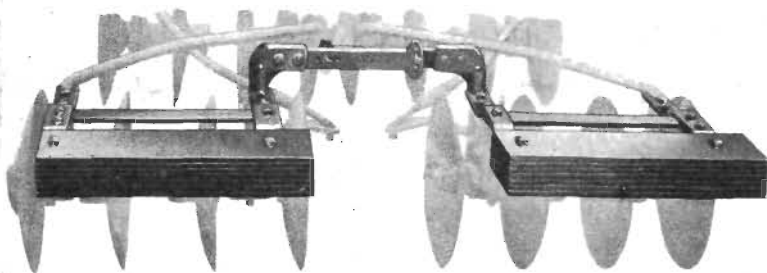


FIG. 179 --Weight attachment for disk harrow.

uniform penetration to the entire width of the harrow. This may be done by means of springs or extra brackets called *snubbing blocks*, all of which act on the lever bars, transmitting the force to the gang as shown in Fig. 180. If springs are used, an extra lever with a yoke, when the lever is brought backward, presses down on the springs forcing the inner end of the disk gang downward. The snubbing block

is bolted to the frame and adjusted vertically by means of elongated bolt holes. By setting the block lower down, additional pressure can be brought to bear on the inner end of the gang.

The rear gangs of double harrows have the reverse action. The outer end kicks up while the inner end digs in. Provision is made on double harrows to hold the inner end up, making uniform penetration.

225. Angling the Gangs.—The gang must be angled to make it penetrate the soil. Ordinarily, when set straight, the gang bolts are at right angles with the tongue. When set in this manner, the disk will not enter the soil. Therefore, penetration is brought about by giving the gang a greater angle. Attached to the bearings extending forward

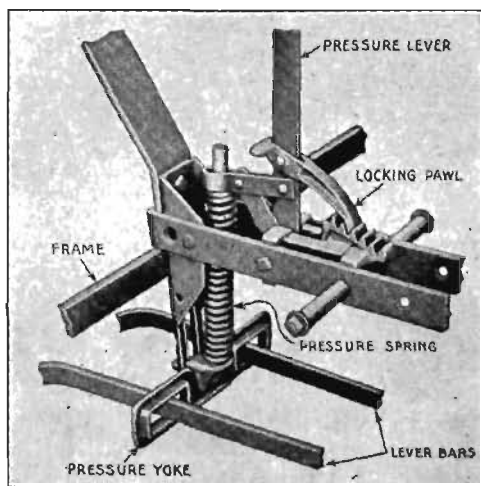


FIG. 180.—Center-depth regulator.

to the lever is the *lever bar*, there being one for each gang. By working the lever backward and forward a greater or lesser degree of angle is given to the gang. The best penetration is obtained at an angle of approximately 20 degrees.

226. Forecarriage.—Disk harrows are constructed with or without tongues attached. If with a tongue, a large part of the weight of the operator and the frame is carried upon the necks of the horses. If a forecarriage as shown in Fig. 174 is placed under the frame, then, there is no weight to be carried on the horses' necks. The principal advantages of the tongue are that better control is maintained over the harrow and shorter turns can be made, but these features are greatly outweighed by the advantages of the forecarriage which takes the weight off the horses' necks; whipping of the tongue is eliminated; and the horses are allowed to turn the harrow with the traces rather than with their necks.

227. Methods of Transportation.—When it is desired to move the harrow any distance, the common method of transporting is to straighten the gangs so that there will be no angle or tendency for the disk to

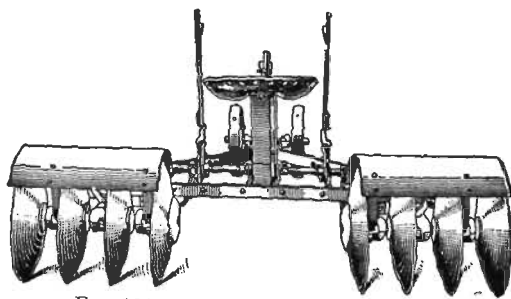


FIG. 181.—Disk harrow for orchards.

penetrate the soil. If there are any rocks, gravel, or obstructions of any kind, the sharp edges of the disks will be greatly injured and battered up. A better method of transporting the harrow is by the use of trans-

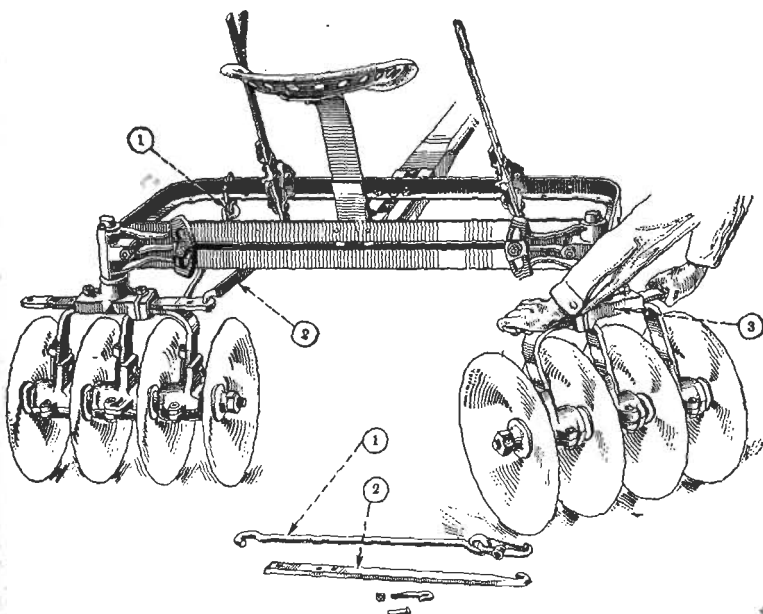


FIG. 182.—Reversible-disk harrow showing method of changing from outthrow to inthrow, or vice versa.

port trucks, as shown in Fig. 178. These trucks are placed under the gangs, elevating them off the ground so that no damage will be done to the disks. There should be one truck for each gang. These trucks can be secured with single or double wheels.

228. The Orchard Disk Harrow.—The orchard disk harrow, as shown in Fig. 181, differs from the regular single-disk harrows by having a wide frame so that the gangs can be set at varying distances apart. It is often desirable to cultivate under low-hanging branches. If the team or tractor is driven too close to the trees, fruit may be injured. With an extension frame the gangs can be set far enough to the side so that they will extend under the branches, cultivating the soil without injuring the fruit. Shields can be purchased to cover the disk and prevent the sharp edges from doing any damage.

229. Reversible-disk Harrows.—The reversible-disk harrow, as shown in Fig. 182, is a single-disk harrow with the gangs constructed in such a manner that they can be reversed to throw the soil either in or out. They

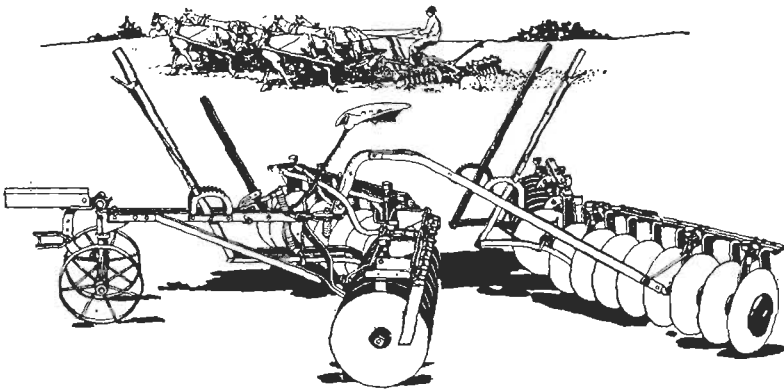


FIG. 183.—Double disk for horses.

are also adjustable for cultivating on ridges. Either end of the gang can be raised or lowered to suit the topography of the soil.

230. The Double-action Disk Harrow.—The double-disk harrow, as shown in Fig. 183, is often called a *tandem* harrow. Two single-disk harrows are attached together, one behind the other. It is from this arrangement that the name *tandem* or *double* is given. The front gangs throw the soil outward. This, of course, if not followed by other disks to throw the soil inward, will leave the soil unlevel. If only the front gangs are used, half of the harrow must be lapped on the next round to accomplish the same result. By the use of the double harrow twice as much is accomplished as when the single harrow is used. The rear disks should split the space left by the disks in front. Very few harrows can be made to accomplish this.

231. Double-action Disks for Horses.—Originally, the double disk was brought out for use behind horses but it was not long before they were being made for use with tractors. The horse disk is usually constructed lighter than that used with tractors (Fig. 183). The front gangs are also

supplied with forecarriages, seats, and levers convenient for the operator who rides upon the harrow.

232. The Tractor Harrow.—Tractor disk harrows, as shown in Figs. 184 to 186, differ from the horse harrows in many respects. First, they are heavier. Second, the forecarriage is eliminated, the frame being

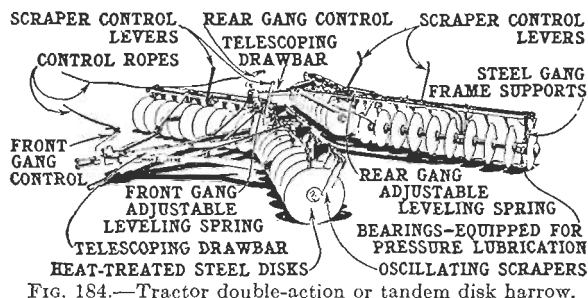


FIG. 184.—Tractor double-action or tandem disk harrow.

attached directly to the top of the drawbar. Third, the levers are arranged differently or eliminated entirely. Fourth, the seat is eliminated because the operator rides the tractor. Fifth, many harrows are provided with power-angling devices. Sixth, it is not necessary in turning at the end to stop and straighten the disk gangs. And seventh, more rigidity



FIG. 185.—Double-action disk harrow drawn by general purpose tractor. Note how gangs are angled for penetration.

in the construction of the harrow can be employed. Single- and double-action tractor disk harrows are provided with extensions of sufficient length that a strip 21 feet wide may be harrowed. The extensions can be folded over on top of the regular gangs to give extra weight and to permit passage through gates (Fig. 186). The various parts of the gang are constructed in the same manner as that described under the single disk, the only difference being that they are made heavier to withstand the

harder use of tractor disk ing. The two rear gangs are always locked together, preventing them from moving more than a measured distance apart.

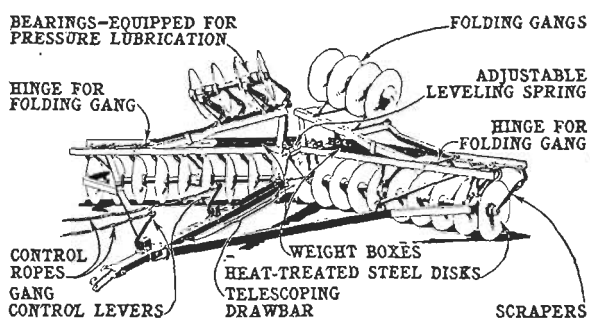


FIG. 186.—Tractor disk harrow, showing extension gangs in folded position.

233. Offset-disk Harrow.—The offset-disk harrow (Fig. 187) is adapted for use in orchards and vineyards, as it can be set to run to the side of the tractor and thus cultivate under branches too low for the tractor to pass under. There are no levers to catch on low limbs. It will work on uneven ground and swing around corners either to the right or left. Large disks 18 to 22 inches in diameter are used on this type of harrow to cut up and turn under heavy trash.

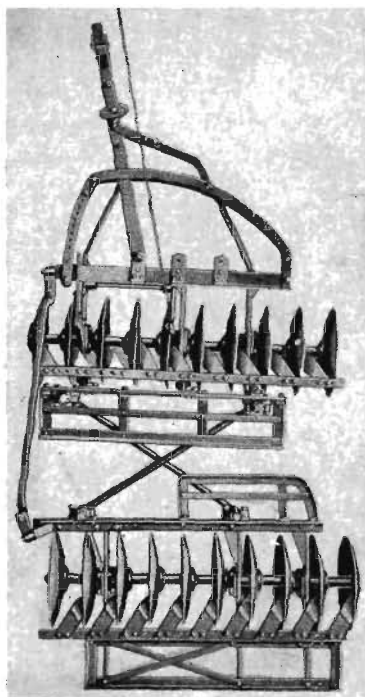


FIG. 187.—Offset-disk harrow.

is pulled forward, the clutch is revolved so that the angle of the gangs is changed. Power for operating the clutch is transmitted by a chain running over a sprocket on the gang bolt of one of the front gangs. The whole apparatus is enclosed in a dust-proof case.

234. Power-angling Devices.—The use of disk harrows behind tractors created a demand for a method of angling the gangs without the operator having to get off the tractor seat and go back to the harrow to change the angle. Several different methods of angling by the tractor power have been developed. Some of these devices operate in a manner similar to the power-lifting devices used on tractor plows (C, Fig. 188). That is, by pulling a rope, a clutch, which is adjustable for various angles, is engaged and as the harrow

Other devices consist of a sliding-bar hitch and an arrangement of levers. (*A* and *B*, Fig. 188). To angle the harrow, the draft lock is raised and, as the tractor moves forward, the gangs take the desired angle. To straighten the gangs for transportation the tractor is moved backward.

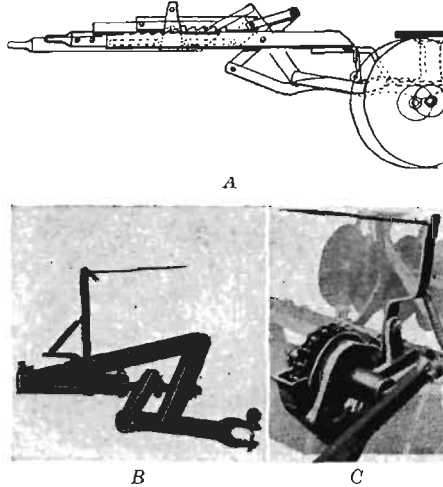


FIG. 188.—Power-angling devices for tractor double-action disk harrows.

235. Soil Penetration of Disk Harrows.—There are many factors within the harrow itself that will influence the depth to which it will penetrate the soil. They are enumerated as follows:

1. The angle of the disk gang.
2. The weight of the harrow.
3. The sharpness of the disks on the gangs.
4. Size of the disks.
5. The dish of the disks.
6. The angle of the hitch.
7. The form of the circumference of the disks whether full, cutaway, or spading.

All of these factors are incorporated within the harrow itself. There are other factors, however, that will influence the depth of penetration with which the harrow has nothing to do, such as the condition of the soil, the amount of moisture, if plowed land or unplowed land, the amount of trash on the soil, and the amount of organic matter that may be in the soil.

236. Draft of Disk Harrows.—No definite data can be given on the draft of the disk harrow because there are a number of factors which will influence the draft; many of them are the same as those which will influence the depth of penetration. Naturally, the angle of the disk gang will cause the disk harrow to go deeper into the soil, resulting in a heavier draft. Tests made by Collins¹ gave the following results:

¹ *Agr. Eng. Jour.*, Vol. II, p. 91, 1921.

TABLE VIII.—DRAFT OF DISK HARROW IN POUNDS

	Sod	Plowed sod	Corn stubble	Cornstalks
Full disk.....	470	610	450	400
Cutaway.....	550	680	510	480

TABLE IX.—ACRES DISKED WITH HORSES PER 10-HOUR DAY

Location and item	Crew ¹	Rate, acres	Location and item	Crew ¹	Rate, acres
Central Illinois:			Minnesota:		
Well-packed land:			Rice County (wheat).....	1—3	18.5
7-foot single disc.....	1—4	15.1	Lyon County (wheat).....	1—4	15.9
8-foot single disc.....	1—4	17.1	Norman County (wheat).....	1—4	18.5
9-foot single disc.....	1—4	18.6	Rice County (flax).....	1—3.4	7.1
10-foot single disc.....	1—6	23.1	Lyon County (flax).....	1—3.7	7.7
Freshly plowed:			Norman County (flax).....	1—4	16.4
7-foot single disc.....	1—4	14.1	Missouri:		
8-foot single disc.....	1—4	15.2	Saline County.....	1—4	10.0
9-foot single disc.....	1—4	16.6	Jasper County.....	1—4	8.6
10-foot single disc.....	1—6	22.3	St. Charles.....	1—3.6	7.4
Colorado:			Montana:		
Rocky Ford district.....	1—3.6	9.1	Gallatin district (wheat).....	1—4.3	18.2
Fort Morran district.....	1—3.8	11.4	Judith district (wheat).....	1—4.5	20.4
Greely district.....	1—3.8	7.4	Billings district, 12 to 16 discs	1—4	10.8
In orchards.....	1—2	5.3	Nebraska:		
Corn Belt:			Phelps County (wheat).....	1—4.5	12.5
Well-packed soil:			Saline County (wheat).....	1—4.2	10.0
6-foot.....	1—2	7.8	Keith County (wheat).....	1—4.2	9.1
6-foot.....	1—3	9.4	Western New York:		
8-foot.....	1—4	15.9	Well-packed land:		
8-foot.....	1—5	13.9	5-foot.....	1—2	8.7
8-foot.....	1—6	18.6	6-foot.....	1—2	9.4
Freshly plowed—			7-foot.....	1—2	9.0
6-foot.....	1—2	7.5	8-foot.....	1—2	10.4
6-foot.....	1—3	7.8	5-foot.....	1—3	9.8
8-foot.....	1—4	13.3	6-foot.....	1—3	10.2
8-foot.....	1—5	11.7	7-foot.....	1—3	10.3
8-foot.....	1—6	15.9	8-foot.....	1—3	10.7
Dakotas:			6-foot.....	1—4	9.5
Grand Forks County.....	1—4	13.0	7-foot.....	1—4	12.7
Morton County.....	1—4	9.3	8-foot.....	1—4	13.8
Spink County.....	1—4.8	13.7	Freshly plowed:		
Great Plains.....	1—4	8.0	5-foot.....	1—2	7.4
Idaho:			6-foot.....	1—2	7.8
Idaho Falls and Blackfoot			7-foot.....	1—2	8.1
district.....	1—3.7	6.9	8-foot.....	1—2	8.1
Idaho Falls district.....	1—3.88	6.5	5-foot.....	1—3	8.4
Twin Falls district.....	1—3	6.2	6-foot.....	1—3	8.5
Provo district.....	1—3.25	9.3	7-foot.....	1—3	8.4
Garland district.....	1—3.93	14.1	8-foot.....	1—3	9.1
Payette district, in orchards,			6-foot.....	1—4	7.9
7-foot riding.....	1—2	5.6	7-foot.....	1—4	10.2
Kansas:			8-foot.....	1—4	11.5
Ford County.....	1—5.2	9.3	Ohio:		
Pawnee County.....	1—4.8	11.0	6-foot.....	1—3.1	9.7
McPherson County.....	1—4.4	10.0	Pennsylvania—Chester County:		
Louisiana:			8-foot single.....	1—2	9.1
6 to 8 foot.....	1—2	5.4	8-foot double.....	1—4	9.5
6 to 8 foot.....	1—4	11.6	Utah.....	1—4	8.6
Maine:			Washington:		
Aroostook County.....	1—2	7.6	In orchards, 5-foot.....	1—2	4.4
Michigan:			Wisconsin.....	1—2	12.5
Caro County, 6-foot.....	1—2.5	8.2		1—3	13.2
Alma County, 6 foot.....	1—2.6	8.6			
Grand Rapids County, 6 foot	1—3.5	7.4			
Grand Traverse County.....	1—3	6.3			
Montcalm County.....	1—3	7.6			

¹ First figure refers to number of men and second figure to number of horses in crew.
U. S. Dept. Agr. Yearbook, p. 1050, 1922.

Both the harrows were 8-foot sizes and just alike with the exception that one was equipped with 16-inch round disk blades and the other with 16-inch cutaway blades with six points each. The draft of cutaway disks is on an average about 15 per cent heavier than the draft of full-blade disks.

WEEDER-MULCHERS

Weeders are excellent tools for making a mulch, for breaking the soil crust over germinating seeds, and for controlling and destroying young weeds just after the field-crop plants have begun to grow. Figure 189 shows a weeder-mulcher.

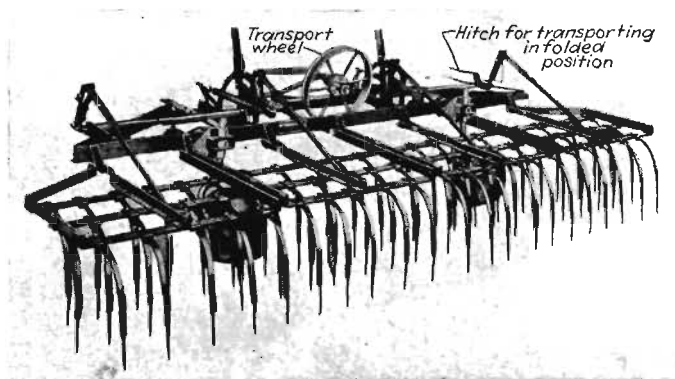


FIG. 189.—Weeder-mulcher.

LAND ROLLERS

237. Kinds and Types of Land Rollers.—Land rollers or clod crushers are tools used for the further preparation of the seed bed. They may be divided into two classes according to the kind of work they do: the *surface packer* and the *subsurface packer*.

There are several different kinds of commercial surface packers, named according to the shape of the roller surface: (1) cast-iron drum roller (2) tube roller, (3) V-shaped or culti-packer.

The subsurface packers consist of: (1) a V-shaped packer and (2) the crowfoot roller.

The surface roller is coming into more general use each year since it has a varied number of uses. (1) The most important is a clod crusher; at this it has no equal. (2) Another very important use is to finish preparing the seed bed by thoroughly pulverizing and firming the loose soil together so that there will not be any large air spaces or pockets. (3) It presses the upper soil down against the subsoil, making a continuous seed bed in which moisture is conserved and given to the roots of the plants as

it is needed. (4) When meadow, wheat land, and pasture land have heaved badly from freezing, the land roller is good to press the soil back down around the roots.

238. Cast-iron Drum Rollers.—The cast-iron rollers, as shown in Fig. 190, are large cylinders made in one large piece or in two or three

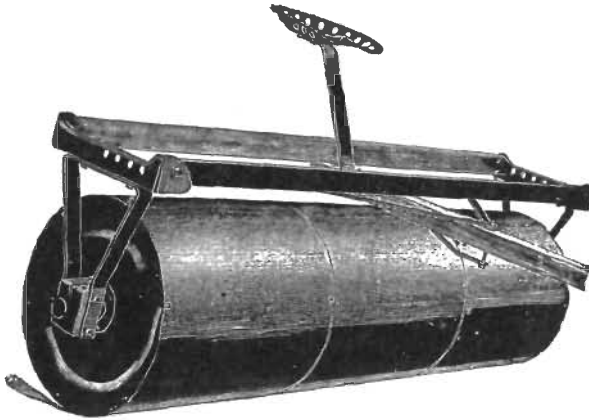


FIG. 190.—Cast-iron drum roller.

sections held together by a long axle passed through the center. This axle will extend out beyond the ends a short distance, allowing the placing of the frame overhead. Midway between each end of the frame is placed a pole upon which the eveners and a seat are fastened, allowing a team to be hitched to the roller to furnish the power and the operator to ride and

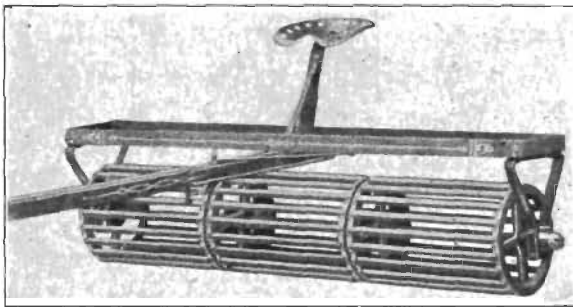


FIG. 191.—Tube land roller.

drive the team. This type of roller, having a smooth surface, will naturally leave the soil very smooth, which is not the best condition for the conservation of moisture. This should be followed by a spike-tooth harrow.

239. The Tube Roller.—A tube roller, as shown in Fig. 191, is built on the same general plan as that of the drum roller but, instead of having a smooth surface, it is made up of a number of short sections on an axle.

Each of these sections is constructed with cast-iron heads in which are tightly set and bolted U-shaped steel cross-pieces. This type of roller crushes the clods, pulverizing the top of the soil, also packing it around

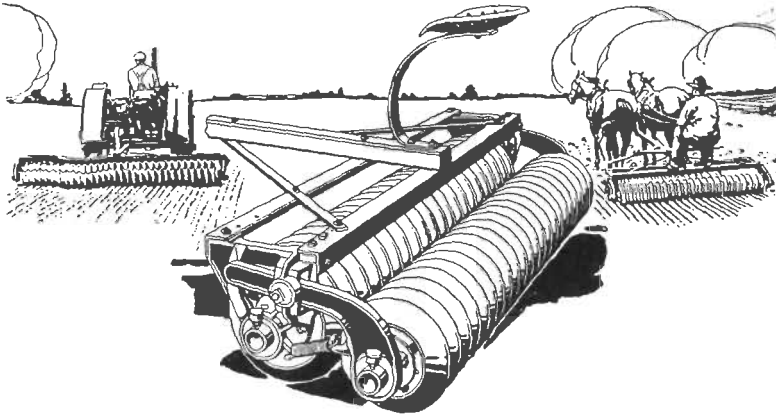


FIG. 192.—Culti-packer can be used with either horses or tractors

the seed. It does not leave a smooth surface as does the drum type of roller.

240. The Culti-packer.—The machine, shown in Fig. 192, is a roller crusher constructed of a number of wheel sections, so that when they are

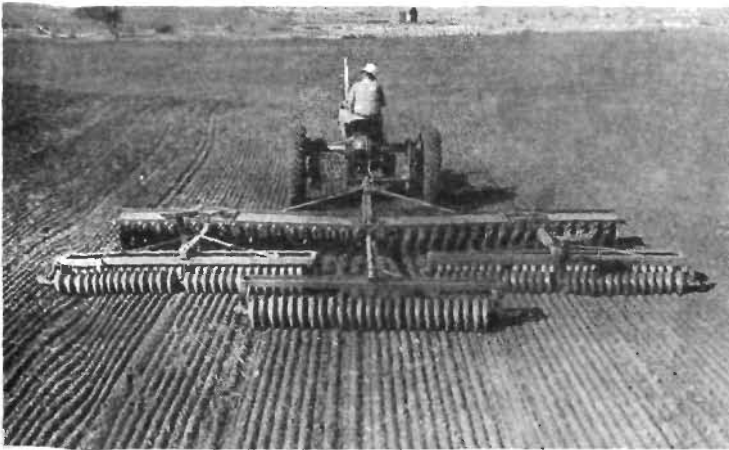


FIG. 193.—Culti-packer land roller in use behind a 21-foot disk harrow.

strung on a shaft the surfaces of the rollers form a kind of corrugation. It is from the shape of the surface which it leaves that it gets the name of *corrugated* roller. Each wheel or section is made about 5 or 6 inches thick and varies in diameter from 10 to 18 inches. The roller is hollow and may consist of one or two pieces and is cast out of semi-steel. When placed upon a shaft and rolled across the soil, it leaves small ridges. If

only one set of rollers is used, these ridges will be rather large, being 5 or 6 inches from one crown to the other. The common method, however, is to use a rear set of rollers which is so arranged that the rear rollers will split the ridge made by the front pair, leaving a number of very fine ridges. It is claimed that this type of roller will prevent wind blowing to a certain extent. It also rolls, pulverizes, packs, levels, cultivates, and mulches the soil in one operation.

241. Homemade Rollers.—Many farmers do not care to go to the expense of buying a commercial type of land roller and will make one to serve the purpose from material that can be had on the farm. The principal types of homemade land rollers are the log roller, mower-wheel, and concrete rollers.

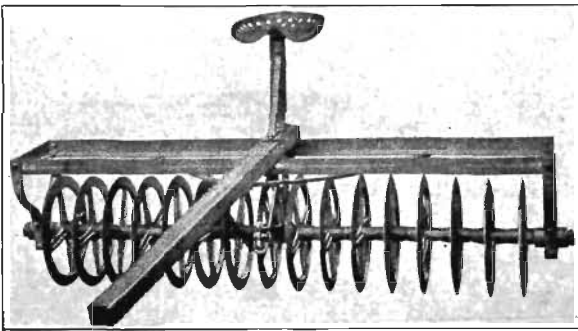


FIG. 194.—Subsurface pulverizer and packer.

242. Log Roller.—The log roller is a common homemade type found on the farm. It consists of a round smooth log with two spikes placed in the ends and a frame built to provide a means of attaching the tongue and eveners. Log rollers should not be very long because when turning, if a wide circle is not made, one end will remain stationary while the other is pulled around. Turning in this manner will have a tendency to dig holes with one end of the roller. It is better, therefore, to use short sections and hinge them together with a knuckle joint of some kind. Such an arrangement will allow easier turning.

243. Mower-wheel Rollers.—In many sections of the country especially in the haying sections, many mowers are worn out and thrown aside. Good land rollers can be made out of the wheels of these machines by stringing them upon a shaft and building a frame, as in the case of the ordinary homemade log roller. Another arrangement can be had with mower wheels by boring a number of holes in the rims of the wheels and bolting 2- by 4-inch wood strips to the rims of two wheels, making a cylindrical roller.

244. Homemade Concrete Rollers.—Smooth, round, concrete drum rollers can be made by pouring concrete in a form. This, of course, makes

a very heavy roller, requiring quite a large amount of power for pulling it. Wooden forms can be easily made to make concrete rollers with V-shaped surfaces similar to the culti-packer. The rollers are strung on a shaft in the same manner as the commercial type of culti-packer.

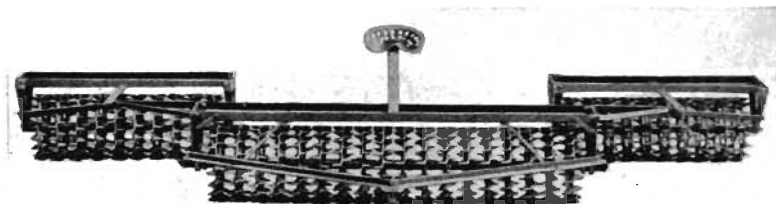


FIG. 195.—Subsurface packer.

245. Subsurface Packer Rollers.—It is often desirable to pack the sub-surface of the soil. Special tools for doing this are called *subsurface packers*. One common type resembles closely the culti-packer. It consists of a number of wheels with V-shaped rims strung on an axle with the frame overhead in the same manner as the culti-packer but, instead of the rims of the wheels setting close together, there is an interval

TABLE X.—SOIL MOISTURE CONTENT IN ACRE-INCHES TO A DEPTH OF 4 FEET IN THE SPRING OF THE CROP YEAR AFTER THE FALLOW PERIOD, OF FALLOW PLOWED ON THREE SPRING DATES, WITH AND WITHOUT SUBSEQUENT SUBSURFACE PACKING, ADAMS BRANCH EXPERIMENT STATION, LIND, WASHINGTON, 1918-1923, INCLUSIVE¹

Tillage treatment	Soil moisture in acre-inches								Relative amount of conserved moisture
	1918	1919	1920	1921	1922	1923	Average	Conserved moisture ²	
Early spring plowing:									
Packed.....	4.91	5.72	5.20	6.03	5.93	5.26	5.51	3.43	101
Not packed.....	4.95	6.22	4.94	5.29	6.01	5.45	5.48	3.40	100
Intermediate spring plowing:									
Packed.....	5.06	5.89	5.33	5.93	5.71	5.31	5.54	3.46	102
Not packed.....	4.67	5.91	5.16	5.50	5.86	5.75	5.47	3.39	100
Late spring plowing:									
Packed.....	4.71	6.28	5.26	5.44	5.46	5.26	5.40	3.32	98
Not packed.....	5.09	6.40	5.06	5.28	5.65	5.22	5.45	3.37	99

NOTE.—All plots were disked at the early spring date, and plowed as indicated. The packed plots were packed with a Campbell subsurface packer weighted to 30 pounds per wheel. All were immediately cultivated with a spring-tooth harrow. Subsequent tillage was given as necessary for weed control.

¹ Wash. Agr. Expt. Sta. Bull. 183, 1924.

² Residual moisture to a depth of 4 feet, 2.08 inches, 4-year average.

of several inches between them (Fig. 194). The rims of these wheels are also rather narrow. Their being V-shaped will allow them to go below the surface, pressing the soil together and leaving a good mulch on top. Another roller which may be classed as a subsurface packer is shown in Fig. 195. The results of conserving moisture by subsurface packing is shown in Table X.

Figure 196 shows a *Meeker harrow* in use behind a disk harrow. The Meeker harrow consists of a large number of disks uniformly spaced on an axle and mounted in a frame. A very fine mulch can be made with this implement.

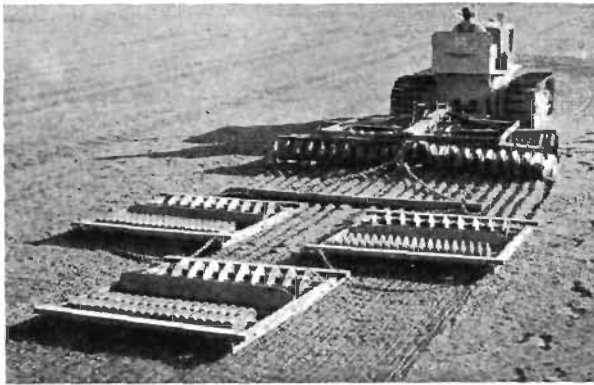


FIG. 196.—Meeker harrow following disk harrow.

246. Drags.—In the preparation of a good seed bed, excellent work can be done by the use of ordinary drags which will crush clods, level the land, and firm the soil around the seed. In many cases the drag can be made to take the place of the roller. There are no commercial types of drags but any farmer can build an ordinary homemade drag that will serve his purpose. The most common drag is that of the *plank* which consists of a number of 2 by 8's or 2 by 10's, or any convenient size of plank, lapped upon one another and firmly fastened by cross sills. Many other types of homemade drags can be made, but are too numerous to mention.

PART V

SEEDING MACHINERY

CHAPTER XVI

CORN PLANTERS

Various methods are used to drop the kernels of corn into the soil, but the specially designed corn planters are used most for this purpose. Such planters are: the hand, the one-row, the two-row drill, and the two- and four-row check-row.

247. The Hand Corn Planter.—Very little needs to be said of this type of planter because of the small demand for it. However, it does come in handy if replanting happens to be necessary. It is constructed with a wedge-like shoe (Fig. 197) which is easily forced into the soil. One side of this shoe is hinged and is connected to the foot-like lever which, when pressed on the ground as the planter is rocked forward, will open this shoe, pressing the soil apart to allow the kernels of corn to drop from the hopper above through a valve that is opened into the soil.

248. One-row Walking Corn Planter.—The one-row walking planter is fully described in the chapter on Cotton Planters. The principal difference in the walking corn planter and the walking cotton planter is in the size of the hopper and plate equipment.

249. Two-row Check-row Corn Planter. This type of planter, as shown in Fig. 198, may be used to plant corn in hills or to drill it in rows. When used as a hill planter, a wire, with buttons on it, makes it possible to plant the hills at equal distances apart in each direction. The distance between hills along the row is the same as the distance between the rows. This arrangement allows cultivation to be made in two directions, which aids in the control of weeds and reduces hoeing to a minimum.

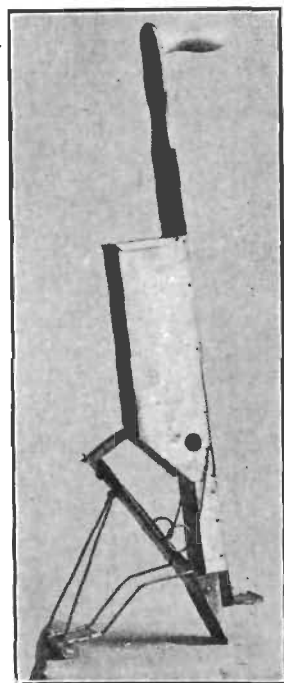


FIG. 197.—Hand corn planter.

The only difference between a check-row planter and a drill planter is that the latter does not have the checking apparatus. There are no valves in the boot, no checking head or wire.

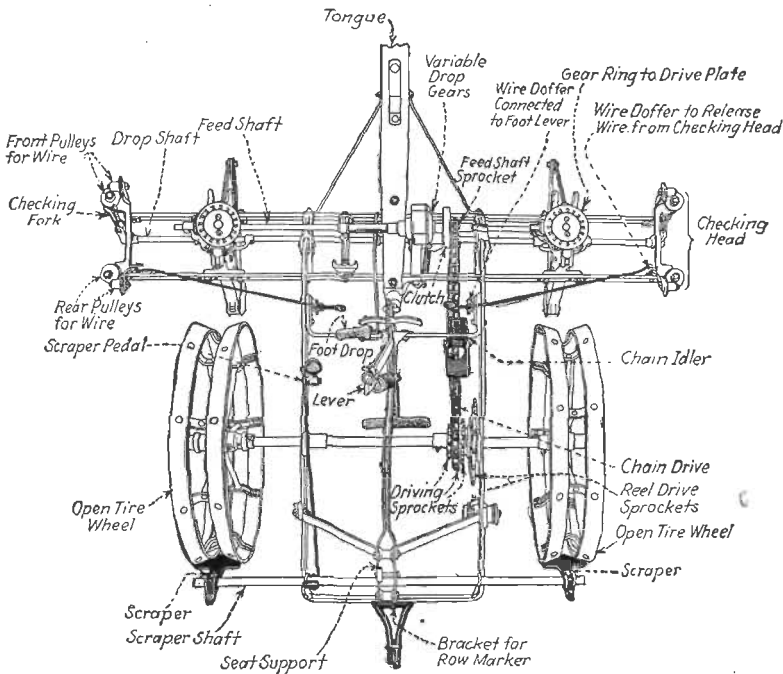


FIG. 198.—Overhead view of check-row planter with the various parts named.

250. Wheels.—The type of wheel used on check-row planters may be either the open-center tire wheel, the closed tire wheel, or the double wheel (Fig. 199). The open-center tire wheel, as shown in Fig. 198, is the most popular and can be converted into a closed-tire full-concave wheel by

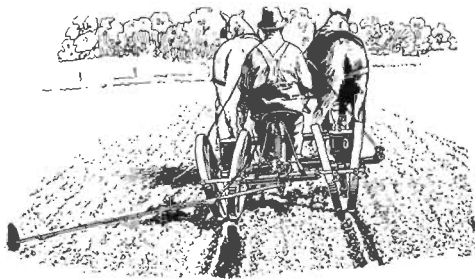


FIG. 199.—Double wheel on check-row planter.

the addition of steel wheel bands. The open-center tire wheel not only carries the planter but serves as both a covering device and a press wheel. Only one wheel furnishes power for operating the dropping devices.

251. The Back Frame.—The frame consists of two units which may be termed front frame and back frame. The back frame is made of a single piece of flat or channel steel. Holes are provided for attaching the axle and its bearings, the front frame, and other parts (Fig. 200).

Sprockets of different sizes are placed on the axle as one of the methods of changing the speed of the feed shaft. A sprocket and clutch for winding up the check wire are also placed on the axle. If a fertilizer or special planting attachments are used, they are driven from the main axle.

252. The Front Frame.—The front frame (Fig. 200) is made of the same type of steel as used in the back frame. Incorporated in the front frame are the various parts of the dropping mechanism. The *boots*

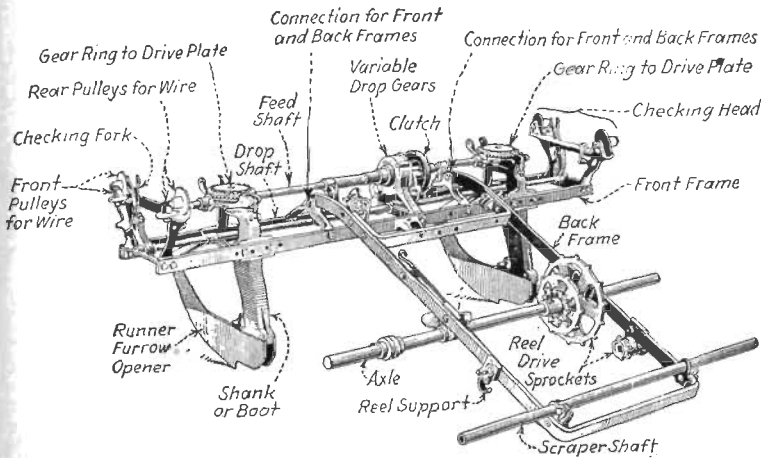


FIG. 200. —Front and back frames of a check-row planter.

attached to the front frame are sometimes known as *shanks*, or *seed tubes*. These are bolted to the front on each side, and can be spaced from 28 to 48 inches apart. A drop shaft to operate the valves in the boot and a feed shaft to drive the plates are mounted on the front frame. On these shafts are found the clutch, the variable drop, the gears for driving the plates, and the check forks. On each end of the frame a check head is mounted to control the check wire.

253. The Feed Shaft.—The feed shaft shown in Fig. 200 is mounted on top of the front frame and is driven by a chain from the main axle. The speed of the shaft is changed by using the different size sprockets on the main axle (Fig. 199). A variable drop mounted on the feed shaft will also change its speed. When drilling corn, the distance between kernels can be varied by changing the speed of the feed shaft. Gears on each end of the shaft drive the seed plates.

254. The Clutch.—The clutch (Figs. 198 and 200) is mounted on the feed shaft, to transmit power from the feed-shaft sprocket (Fig. 199) to the feed shaft. The sprocket runs loose on the feed shaft but when the clutch units (Figs. 201 and 202), which are keyed to the feed shaft, are engaged, the shaft is revolved. When drilling corn, the clutch remains engaged and keeps the feed shaft turning steadily. When corn is being

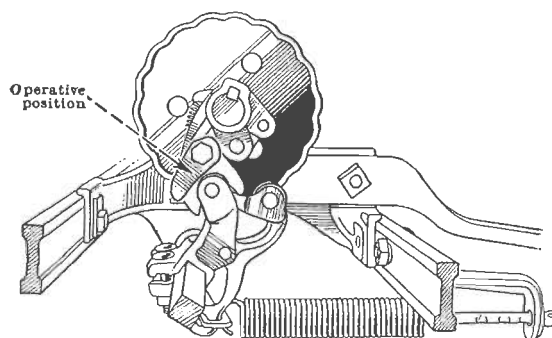


FIG. 201.—Clutch on check-row planter in engaged position.

check rowed the clutch is engaged before and disengaged after each hill is planted. The clutch is operated automatically by the buttons on the wire, which also causes the feed shaft to turn intermittently.

255. Corn Seed Plates.—There are four types of seed plates used for planting corn, namely, the edge-drop and the flat-drop, which have the cells around the outer edge of the seed plate; the flat-drop round-hole

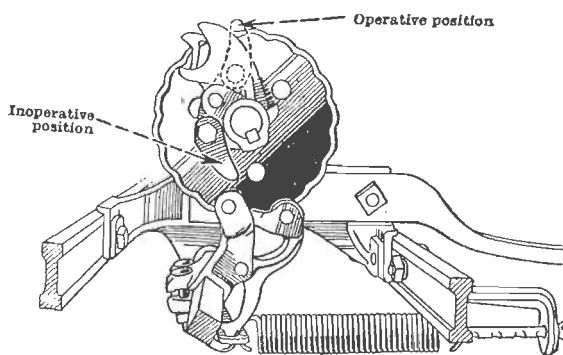


FIG. 202.—Clutch on check-row planter in disengaged position.

cells; and the full-hill plate. The edge-drop (Fig. 203) carries the kernel of corn on edge in the cell of the plate. The flat-drop (Fig. 204) carries the kernel flat in the cell of the plate. Only one kernel of corn is selected in each cell at a time. As the plate revolves, the kernels are dropped upon the top valve until the desired number of kernels have been accumulated; then, the valve is opened and they are dropped upon the lower

valve, and next, into the soil. Figure 209 shows kernels of corn being dropped by the valves.

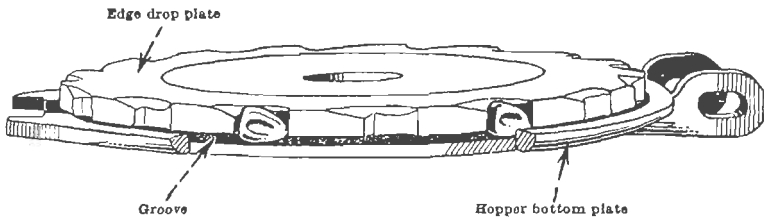


FIG. 203.—Edge-drop plate assembly showing position of kernel.

The full-hill plate (Fig. 205) has cells around the outer edge large enough to admit several kernels at the same time. Kernels enough for

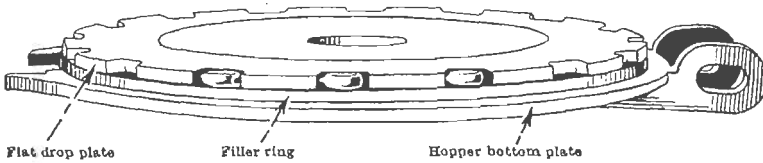


FIG. 204.—Flat-drop plate assembly showing position of kernel.

one complete hill are dropped upon the valve without having to be accumulated.

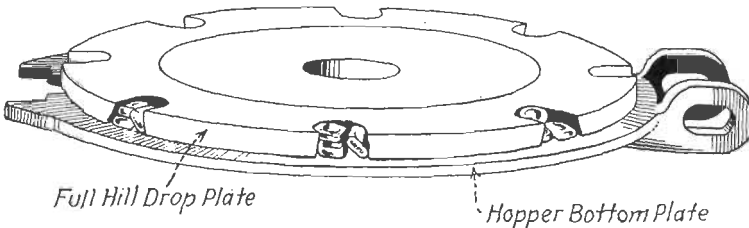


FIG. 205.—Full-hill drop plate with kernels in the cells.

The flat-drop round-hole type of plate (Fig. 206) is not used on check-row planters but is used on many drill planters.

Kernels of corn do not vary greatly in thickness. They do, however, vary considerably in width. It is essential to carefully select a plate having cells of sufficient thickness to prevent cracking of the kernels as they pass under the cut-off cover plate. Where the kernels are selected to lie flat in the cell, several plates are furnished, having cells adapted to small, medium, and large kernels. Both the edge-drop and the flat-drop plates do satisfactory work provided the size of the cell suits the size of the kernel. In each type the corn should be graded to a uniform size. This is more important in the edge drop than in the flat drop.

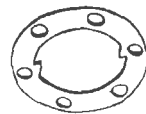


FIG. 206.—Corn plate with round hole cells.

256. Selecting and Dropping of Seed.—The accuracy of a planter depends upon the uniformity of kernels, shape of hopper bottom, speed of the plate, shape and size of the cells, and fullness of the hopper.

A crowned hopper bottom (Fig. 207) causes the seed to gravitate into the cells. Frequently more than one kernel is partially in the cell.

The yielding *cut-off* pawl (Fig. 207) acting under spring pressure pushes the extra kernels back as the cell passes under the plate cover or it cuts them off from the cell and, at the same time, presses the kernel firmly into the cell.

As the plate revolves to where the cell is over the seed tube a yielding *knock-out* pawl under spring pressure comes in contact with the kernel, knocking it through the cell into the seed tube, where it is allowed to fall either upon the valve, if checking, or directly into the soil, if drilling.

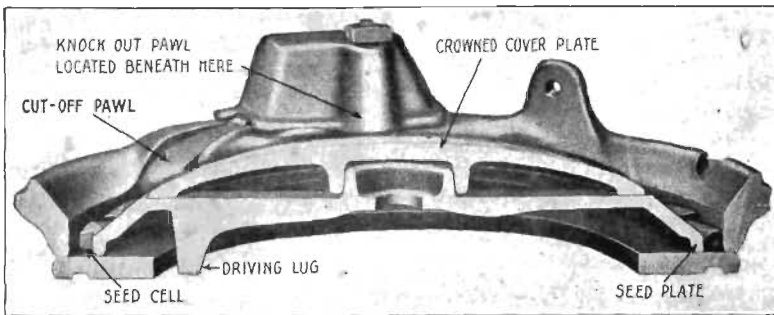


FIG. 207.—Cross-section of hopper bottom, plate, and cover showing cells and cut-off pawl.

257. Drive for Seed Plate.—On each end of the feed shaft is a bevel-gear pinion which meshes with the plate gear and drives the plate by means of a lug in contact with a lug on the plate (Fig. 208).

258. The Variable Drop.—All check-row planters are provided with devices to vary the speed of the plate and change the number of kernels in the hills. One part of the field may be fertile land and four kernels would be desired while another part may be poor land and two or three kernels would be sufficient.

The most common method consists of a set of three gear changes mounted upon the feed shaft. The gears are enclosed in an oil-tight case and the change in the number of kernels is made by shifting a conveniently located foot lever. To plant two kernels, the feed shaft makes only a half revolution which causes two cells to pass over the valve. When three kernels are desired, the feed shaft makes three-quarters of a revolution. To plant four kernels, the feed shaft makes a complete revolution.

Other variable drops may consist of three rows of teeth on the seed-plate gear. A pinion gear shifted to either row of teeth will change the

number of kernels. Another method is to have a pinion with three rows of teeth on each end of the feed shaft.

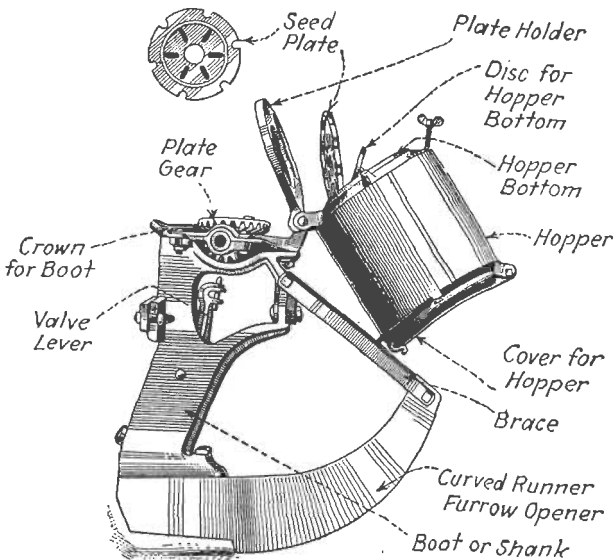


FIG. 208.—Planting assembly for drill and check-row planters.

259. Valves.—Most check-row planters have two valves (Fig. 209) in the boot or shank—a few of them have three. One of these is located at the top of the boot just under the seed plate, while the other is at

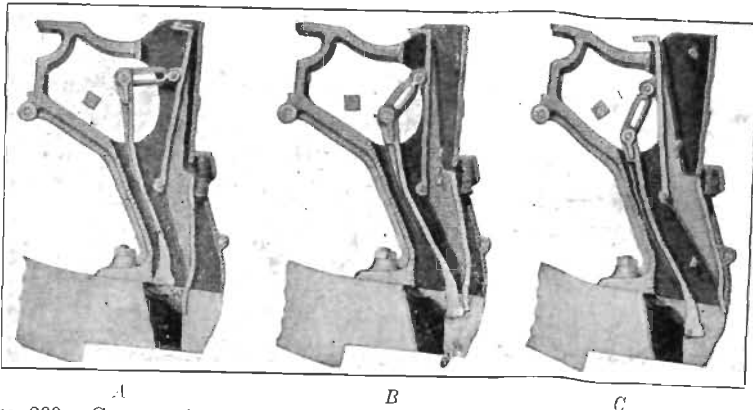


FIG. 209.—Cross-sectional view of check-row planter boot, showing action of the valves: *A*, valves closed with kernels of corn in each; *B*, valves open showing lower valve ejecting corn into the soil and the corn dropping from the upper valve to be caught by the lower valve; *C*, valves locked open for drilling.

the bottom of the boot and in the rear part of the furrow opener. The two valves open and close at the same time. Kernels of corn accumu-

lated on the top valve, while closed, are dropped and caught by the lower valve when the buttons on the wire trip the check fork and open both valves. Springs close the valves so quickly that the kernels do not have time to pass from the top valve into the soil before the lower valve closes.

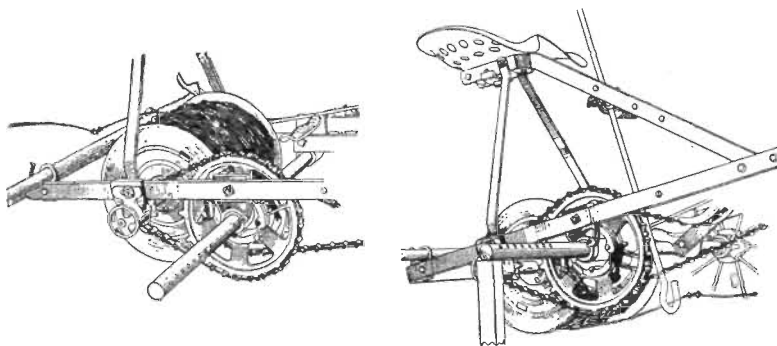


FIG. 210.—Method of laying out and reeling up wire.

The lower valve is necessary to prevent the hills being staggered and the kernels scattered. When drilling is desired, the valves can be locked open, allowing the seed to drop from the seed plate directly into the soil.

260. Check Wire.—The check wire is usually furnished in 80-rod lengths, having buttons anywhere from 30 to 48 inches apart. Special wire with shorter spacing can be secured. At intervals of 5 or 6 rods special spreading links are provided so that the wire can be disconnected and passed around obstructions such as trees.

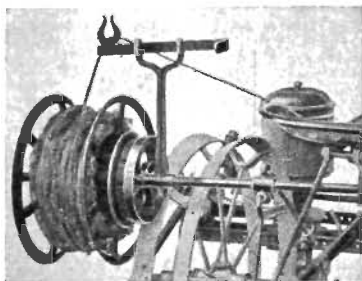


FIG. 211. Wire reel attached to side of planter.

When the planter is not being used, the wire is rolled up on a reel which may be suspended beneath the seat (Fig. 210) or carried to one side of the planter (Fig. 211).

261. Operation of Check-row Planter in Field.—It is often difficult for the student to fully understand the relation of the various steps in the operation of a check-row planter. Hence, they are given here:

1. Laying out and handling wire.

The first step in the field is to lay out the wire. Drive the planter to edge of field and place it in first position shown in Fig. 212. Hook wire on anchor stake; then, set stake to rear of planter about four times the distance between rows toward the edge of the field.

Drive carefully straight across the field unreeling the wire. Upon reaching opposite side of field detach wire and turn planter in second position (Fig. 212) for planting the first two rows. Hook the other anchor stake to wire drawing wire fairly tight, and set stake directly behind the center of the planter. Place wire in checking head.

The required tension on the wire can be determined by using spring balances or special registers.

For rows 30 rods or less, pull to 30 pounds.

For rows 40 rods, pull to 40 pounds.

For rows 50 rods or more, pull to 50 pounds.

The planter is again driven across the field, this time planting. Upon reaching opposite side of the field, the wire is released from the checking head by means of the wire doffer. Turn the planter to third position (Fig. 212), change row marker to opposite side of planter; move the anchor stake to directly behind center of planter, drawing wire to same tension as before; then, place wire in checking head and drive to opposite side and repeat operations there.

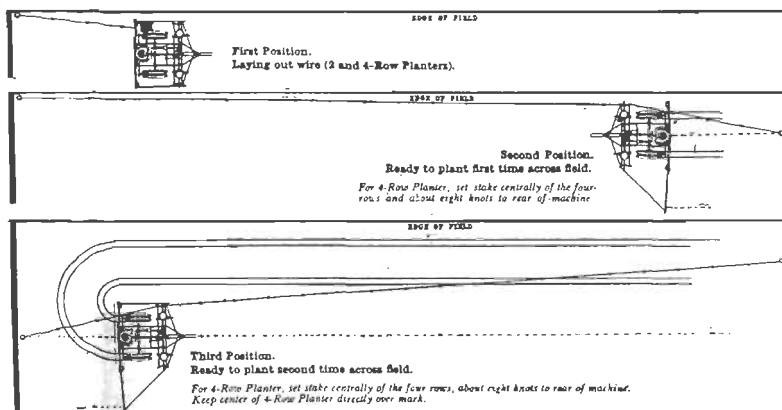


Fig. 212.—Steps in the operation of a check-row planter.

2. The wire being stretched across the field is now placed in the checking head, through the roller guides and the check fork (Figs. 199 and 200).

3. Lower the row marker toward the field.

4. Now the planter is driven across the field with the buttons striking the checking fork, bending it down.

5. As the buttons bend the check fork down the valves are opened and the clutch engaged. When the button slips over the bent down check fork, the fork returns to an upright position, allowing the valves to close and the clutch to disengage.

This action in turn brings about the following operations:

a. Kernels on the lower valves drop into the soil.

b. Kernels on the upper valve drop to the lower valve.

c. The clutch engages which causes the seed plates to turn and accumulate seed on the upper valve for another hill. This action occurs between the times the buttons act on the check fork.

In operating check-row planters it may be difficult to align the hills across the field at right angles to the direction of travel. That is, the hills may be dropped too close or too far from the button. On most horse-

drawn planters this can be corrected by adjusting the connection under the pole. If the hills are too close to the button, lower the front frame; if too far from the button, raise the front frame. This is true when the wire has been stretched to the proper tautness. Do not try to correct the trouble by shortening or lengthening the neck yoke straps, as this will cause the furrow openers to run shallower or deeper, respectively.



FIG. 213.—Tractor-mounted four-row check-row planter. Note the cross-over attachment for the check wire.

When four-row tractor check-row planters are used, the width of land planted is twice that planted with a two-row planter. Consequently, it will be necessary to leave a wider headland, and the wire will have more "travel." "Wire travel" is caused by the planter's pulling the

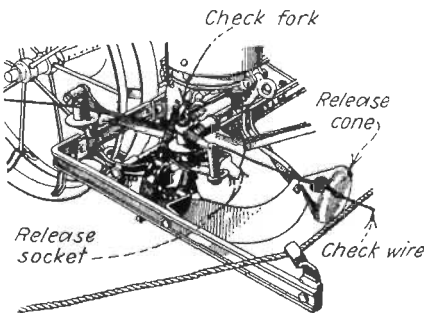


FIG. 214.—Automatic check-wire release.

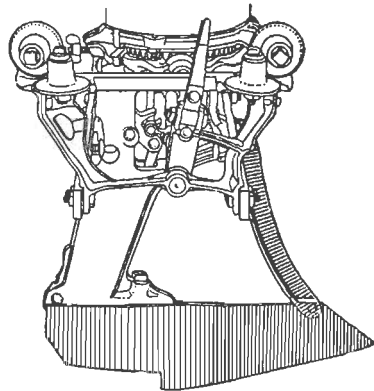


FIG. 215.—Stub-runner furrow opener.

wire tight behind it and pushing the slack ahead of it. With the four-row planter there is greater wire travel than with the two-row, owing to the increased "wire crawl," or movement of the wire sidewise, and the greater angle at the headlands. To offset this trouble a "cross-over" device should be used on four-row check planters. As shown in Fig. 213,

when the cross-over mechanism is used, the tractor is first headed toward the center of the field and aligned parallel to the direction of travel, then the stake at the end of the headland is set directly behind

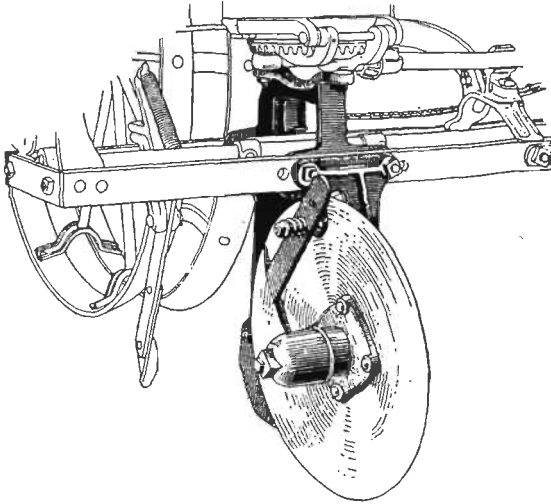


FIG. 216.—Single-disk furrow opener.

the checking head. With this arrangement there is neither wire crawl nor angle of the wire on approaching the headland.

262. Furrow Openers.—Furrow openers are necessary to open furrow-like trenches in the soil to receive the seed as they are dropped by the dropping mechanism of the planter. On check-row planters four types are used.

The curved runner is shown in Fig. 200; the stub runner in Fig. 215; the single disk in Fig. 216, and the double disk in Fig. 217.

The curved-runner type of opener is used most. The stub runner is suited to rough and stony ground. The double-disk opener is used where a wide furrow is desired.

263. Attachments for Furrow Openers.

Various types of attachments are shown in Figs. 218 and 219. A furrowing and covering attachment is shown in A Fig. 218. The first blades push away the

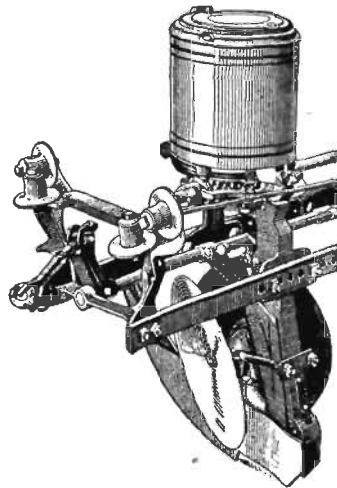


FIG. 217.—Double-disk furrow opener.

rocks and clods, permitting

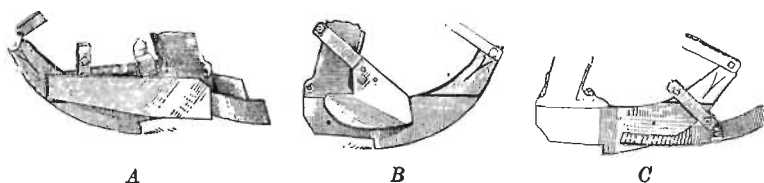


FIG. 218.—Attachments for curved-runner furrow opener: A, furrowing and covering attachment; B, furrowing attachment; C, gage shoe.

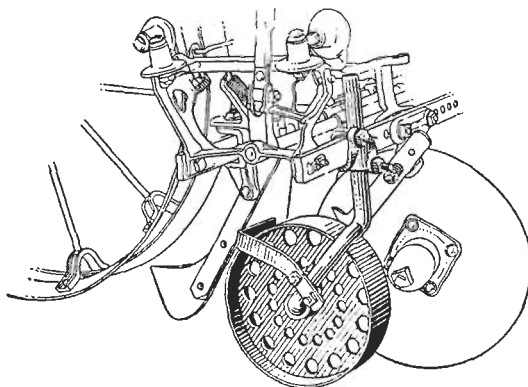


FIG. 219.—Gage-wheel attachment for single-disk furrow openers.

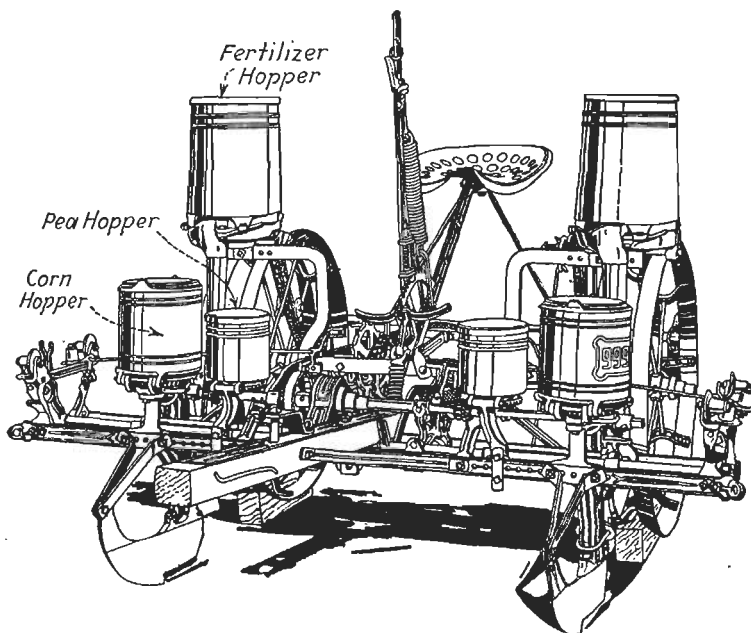


FIG. 220.—Check-row planter equipped with fertilizer-distributor and pea-planting attachments.

the rear covering blades to scrape in a sufficient quantity of earth to cover the seed.

The furrow attachment *B* Fig. 218, also provides a shallow furrow in which to plant the seed.

The gage shoe shown in *C* Fig. 218, makes it possible to maintain a uniform depth in loose and mellow soils.

A gage-wheel attachment (Fig. 219) is used in conjunction with the single-disk furrow opener to regulate the depth of planting.

264. Row Marker.—Row markers are essential to keep the rows straight, parallel, and of equal distance apart. A reversible-disk type is shown in Fig. 199 while a double-folding type is shown in Fig. 213. Double-disk markers are also used.

265. Special Attachments.—Several attachments are available for all types of planters. A fertilizer-distributing attachment may be mounted on any of the modern corn planters. Attachments are shown on a two-row planter in Fig. 220. The details of the types of feeds and rate of distribution are discussed under Fertilizer Machinery. Some of the attachments

on check-row planters, however, are provided with a valve that is operated by the check fork in unison with the valves of the planting mechanism. Some farmers often use the regular planting mechanism to distribute fertilizer. This cannot be done if the fertilizer is very sticky. When used in this manner, it should always be thoroughly washed to prevent injury to the metal parts.

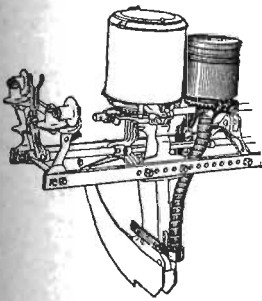


FIG. 222.—Pea attachment.

Figure 222 shows a pea or soybean planting attachment mounted on the front frame and driven by gears clamped on the feed shaft. When this type of planter is sold in the South and Southwest, plates for the planting of cotton and sorghums are furnished as regular equipment. The hopper is made larger to meet the requirements of cotton planting.

266. Duty of Planters.—An average of 7.1 acres can be planted in a 10-hour day with the one-row one-horse planter when the rows are $3\frac{1}{2}$ feet

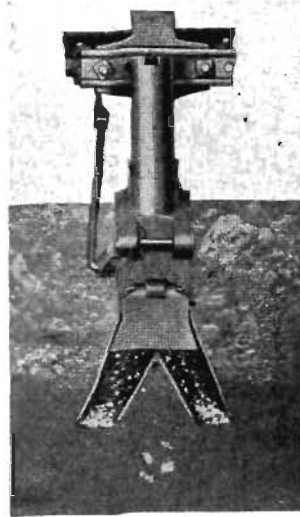


FIG. 221.—Attachment on corn planter for placing band of fertilizer on each side of the seed.

apart. With the same width between rows, a two-row two-horse planter will plant 14.1 acres.¹ The duty of a two- and four-row tractor is practically the same as for a cotton planter.



FIG. 223.—Four-row corn drill drawn by general purpose tractor equipped with rubber tires.

267. Draft of Corn Planters.—Very little is known about the draft of a corn planter. However, it is considered a light load for two horses or mules.

U. S. Dept. Agr. Yearbook, p. 1056, 1922.

CHAPTER XVII

COTTON PLANTERS

The modern cotton planter is designed so that cotton, corn, and sorghum plates are interchangeable in the same hopper. The general construction features are different from the corn planter. As a general rule cotton is planted on a ridge. However, in the subhumid areas it is planted, as other crops are, in the listed furrow.

268. Primitive Types of Cotton Planters.—The first attempts to improve upon the hand method of planting cotton was to take a cow horn, plunge it into a bag of seed, and then scatter them along the furrow. Other early and ingenious arrangements consisted of a barrel or keg, making what was known as a *barrel planter*. A quantity of sand and gravel was mixed with the cotton seed in the barrel, for the purpose of

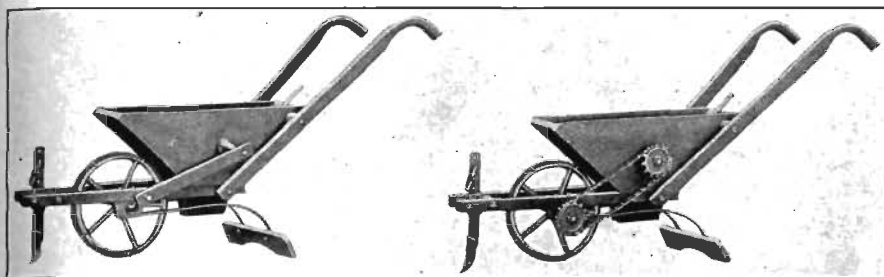


FIG. 224.—Dow-Law cotton planter.

FIG. 225.—Carolina cotton planter.

preventing the seed from clinging together, so they would fall through holes that had been bored at intervals around the middle of the barrel.

269. First Improved Cotton Planters.—The first great forward step in cotton-planting devices was the invention of the Dow-Law planter (Fig. 224), about 1874. The features of this planter included a trapezoidal wooden hopper mounted on a wooden frame, at the front end of which was a steel furrow-opener blade and, just to the rear, a drive wheel. In the center, at the bottom of the hopper, was an adjustable feed gate, by which the flow of seed could be regulated.

A slight improvement over the Dow-Law planter was the "Carolina cotton planter," as shown in Fig. 225. The general construction was practically the same. The principal differences were in the type of agitator and the method by which it was driven. Instead of a pitman,

a chain running over sprockets was substituted which gave a rotary instead of a reciprocating motion to the agitator.

Many of both the Dow-Law and Carolina planters are still being made and sold by several of the leading implement manufacturers.

270. Modern Types of Cotton Planters.—The modern cotton planter is really a combination type designed to plant seeds of most of the field row crops. Owing to the wide variety of conditions, there are many different types, as shown by the following list:

One-row walking:

Regular cotton and corn.

Lister.

One-row riding:

Regular cotton and corn.

Lister planters.

Two-wheel narrow.

Three-wheel narrow.

Four-wheel wide tread.

Two-row riding:

Regular cotton and corn.

Corn-drill type.

Two-row listers.

Three-row tractor.

Four-row tractor.

271. One-row Walking Planters.—The regular one-row walking planter is very similar to the regular corn planter in the arrangement of

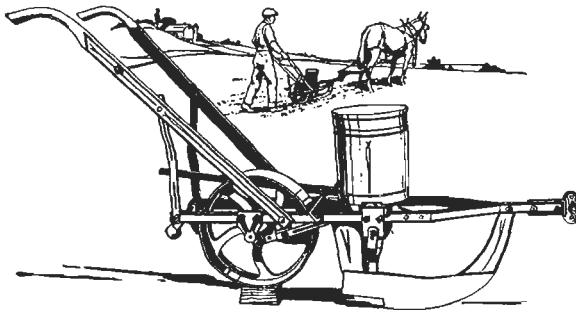


FIG. 226.—One-row walking cotton and corn planter with drive wheel in the rear of the furrow opener.

the frame, type, and location of wheels, and method of driving the seeding mechanism. The planter shown in Fig. 226 is equipped with runner furrow opener, pitman drive, and a large, wide-tired wheel which also drives the plates, covers the seed, and presses the soil around them.

The most popular type of one-row walking planter used in the cotton belt is shown in Fig. 227. The cast-iron wheel with its narrow T- or V-shaped tire is placed to the front of the frame. The power for driving

the plates is transmitted by a chain or two pitmans. A pitman is connected to cranks on each side of the wheel and seed box. Some planters use a gear-shaft device instead of the pitman drive. Reversible shovel furrow opener and covering shovels are used. The planter can be obtained with or without a hill-drop valve in the boot. Figure 228 shows a one-row walking planter equipped with a runner furrow opener, with knife coverers, and with press wheel and fertilizer attachment. The

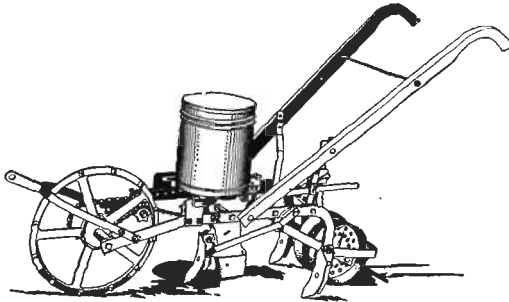


FIG. 227.—Planter equipped with hill drop. A chain transmits power to drive the seed plates and hill-drop valve.

press-wheel and fertilizer attachment are optional. The press wheel serves both as a depth gage and as a press wheel.

272. One-row Riding Cotton Planter.—The most popular one-row riding type of cotton planter is shown in Fig. 229. It is designed to plant on the level, on beds, or in furrows. Cotton is planted on ridges or beds to secure good drainage and allow the top of the bed to become warm early in the spring, which hastens germination of the seed.

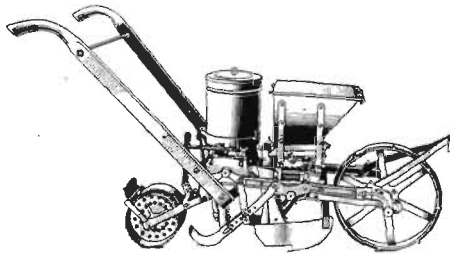


FIG. 228.—Cotton planter equipped with runner furrow opener, knife coverers, press wheel, and fertilizer attachment.

273. Frame.—In most one-row riding cotton planters the frame is one continuous piece of flat or channel steel, well braced to make it rigid. Axle braces bolt to the frame and carry the axles beneath it.

274. Axle.—The axle is usually a straight piece of cold-rolled steel shafting about $1\frac{3}{8}$ inches in diameter.

A spur or bevel gear for driving the planting mechanism is carried on the axle inside of the frame.

If a fertilizer attachment is used, a sprocket is slipped on one end of the axle next to the frame to furnish the power.

275. Wheels.—Both wheels furnish power for driving the planting mechanism. A ratchet and pawl is used in the hub of each wheel. The wheels have removable boxings. The tread of the wheels may be varied from 32 to 44 inches to suit different widths between rows. Tires may be flat, oval, or concave in shape. The flat tire is better for black and sticky soils while the concave tire is better for sandy soils.

276. Clutch.—On most planters a clutch is placed on the axle in connection with the driving gear so that the planting mechanism can be easily engaged and disengaged. Where no clutch is provided, the

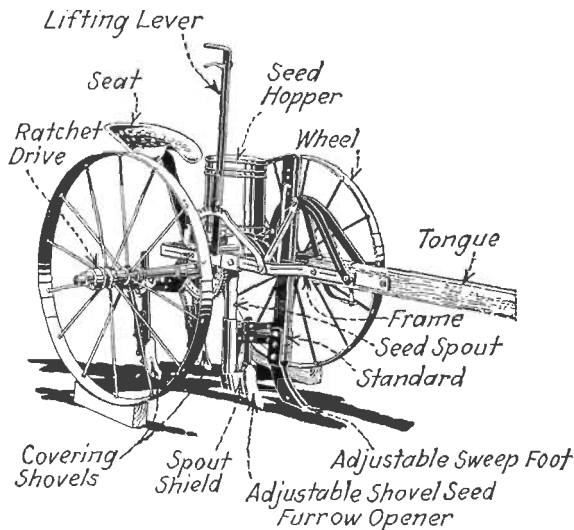


FIG. 229.—One-row riding cotton and corn planter.

planting mechanism is thrown in and out of gear by lifting the hopper so the gears do not mesh. In either case this is done automatically as the plow and furrow opener are lifted.

277. Cotton-dropping Devices.—Gin-run cotton seed is universally used for planting. This is seed with lint adhering to it the same as it comes from the cotton gin. Two types of dropping mechanisms are used on cotton planters. They are the *cell drop* and the *picker-wheel drop*.

278. The Cell Drop.—A typical cell drop is shown in Fig. 231. It consists of a plate with cells on the outer edge. As the plate turns the agitators separate and stir the seed, causing them to work down into the cells off a sloping collar, and under feed springs which gently force more or less seed into each cell. Then, the yielding cut-off pushes back the surplus and, as the cells pass over an opening, a yielding spring controlled knock-out partially drops into the cell forcing the seed through

the plate into the spout below. A small wheel with spur-like fingers projecting into each cell is also used as a knock-out device.

The manner in which the seed are distributed is shown in Fig. 232. With average size seed the quantity dropped by the cell drop ranges from

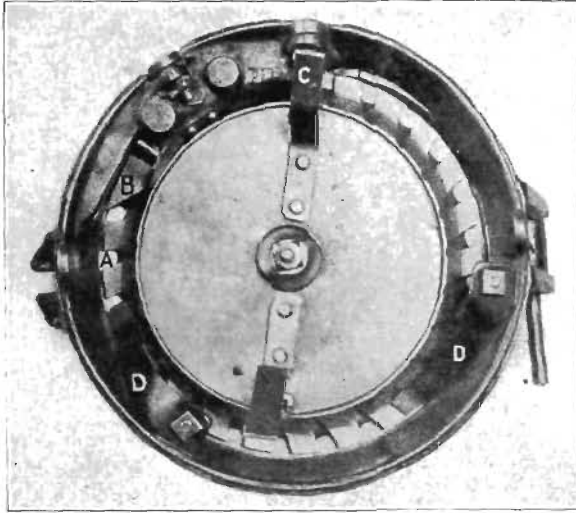


FIG. 230.—Cell-drop cotton-dropping mechanism with hopper removed: A, cell; B, cut-off; C, agitator arm; D, feed springs.

$\frac{1}{3}$ to slightly more than 1 bushel per acre. The quantity is varied by changing the speed of the plate and by changing plates which have different size cells.

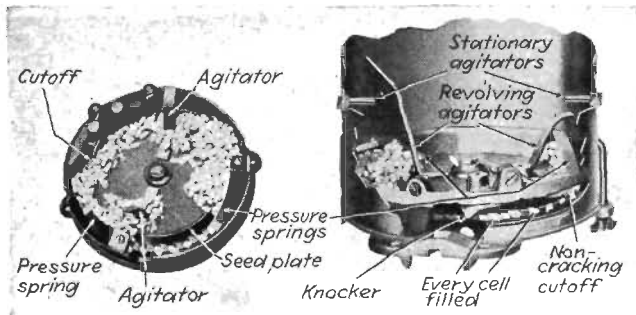


FIG. 231.—Cell-drop cotton-dropping mechanism showing the various parts.

Many claim that this type of drop injures a large quantity of seed but, according to tests conducted by the author, the percentage of injury hardly ever is greater than 1 per cent.¹

The cell drop is best suited to loose, loamy, and sandy soils.

¹ *Tex. Agr. Expt. Sta. Bull.* 526, p. 19, 1936.

Special planters, that work fairly satisfactorily, have been designed to drop cotton seed in hills.

279. The Picker-wheel Drop.—A representative type of the picker-wheel drop is shown in Fig. 233. It consists of a horizontal rotating



FIG. 232.—Cotton seed dropped by cell-drop planter.

agitator plate (a) with fins or fingers (b) radiating outwardly from the body of the plate. The fingers are so designed as to press the cotton seed downward on the picker wheel (c) revolving in an opposite direction, and at right angles against the movement of the agitators. This picker

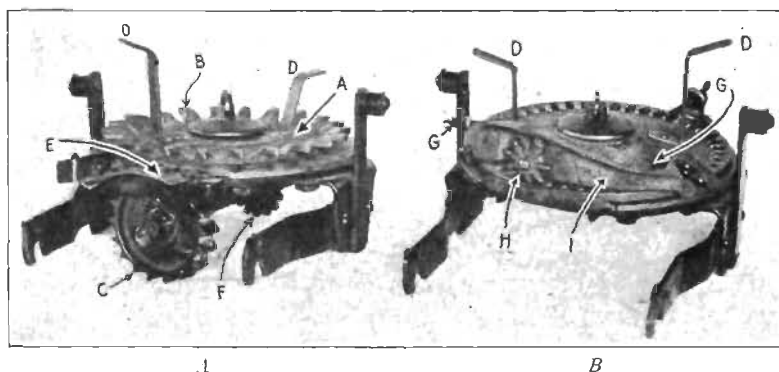


FIG. 233. Cotton-dropping devices with hoppers removed: A, picker-wheel drop; B, cell drop.

wheel really picks the seed from the mass forced down on it. The wheel is usually about $\frac{3}{4}$ inch wide and has notches, having a sharper slope on the front side than on the rear. It does not extend above the bottom of the hopper as a general rule.



FIG. 234.—Cotton seed dropped by a picker-wheel dropping device.

The quantity of seed is regulated by exposing more or less of the picker wheel to the seed by means of a sliding gate shutter. The quantity of average size cotton seed planted, can be varied from about $\frac{1}{3}$ bushel to better than 3 bushels per acre. The manner of depositing the seed is shown in Fig. 234.

The picker-wheel drop injures an average of 0.20 of 1 per cent. This type of drop is best suited to black heavy crust-forming soils. A large number of germinating plants are often necessary to break through a heavy crust formed on the top of the soil.

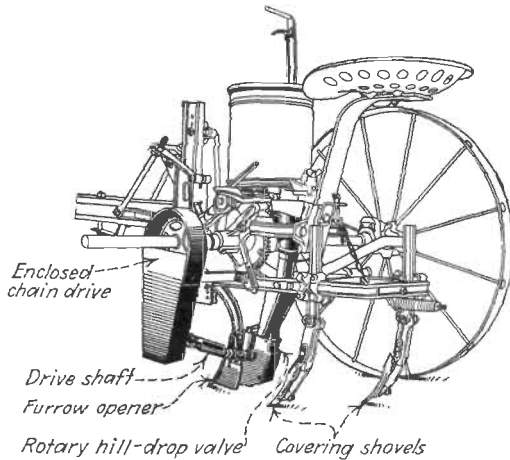


FIG. 235.—Rotary hill-drop valve on one-row riding cotton planter.

Hill-dropping picker wheels are made by some manufacturers.

280. Hill-drop Mechanisms.—The first hill-drop mechanisms used consisted of cells spaced at suitable intervals in the planter plate and large enough to hold sufficient seed for one hill, or picker wheels having notches

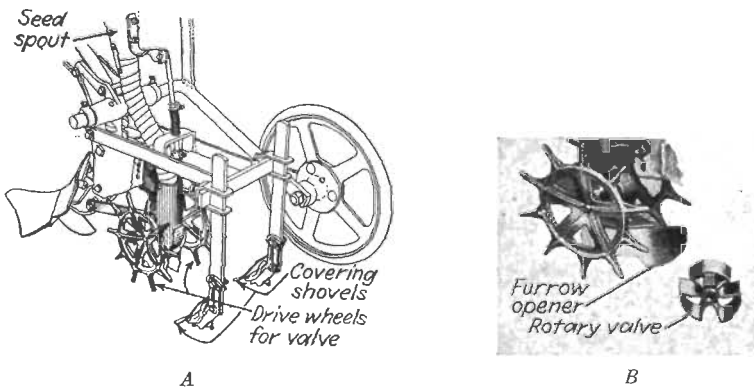


FIG. 236.—Hill-drop mechanism for tractor planter: A, showing position of hill-drop; B, rotary valve for dropping hills.

in their surfaces, so spaced as to drop the seed in hills. These kinds of hill drops were located in the bottom of the planter hopper, and it was necessary for the seed for each hill to fall from the hopper through the seed tube to the soil. In falling a distance of some 18 or 20 inches the seed

became separated and scattered along the furrow to such an extent that it was difficult to distinguish one hill from another. Later someone conceived the idea of placing a valve in the lower part of the seed boot, low enough to the ground to prevent the seed from scattering when they were dropped (Fig. 235). Walking and riding horse-drawn planters and tractor planters are now available equipped with hill-drop mechanisms. Horse-drawn planters are equipped with a trip or rotary valve in the boot, while tractor planters are equipped only with the rotary-valve type of hill drop (Fig. 236). The trip-valve type will not withstand the strain of the higher speeds attained by tractors.

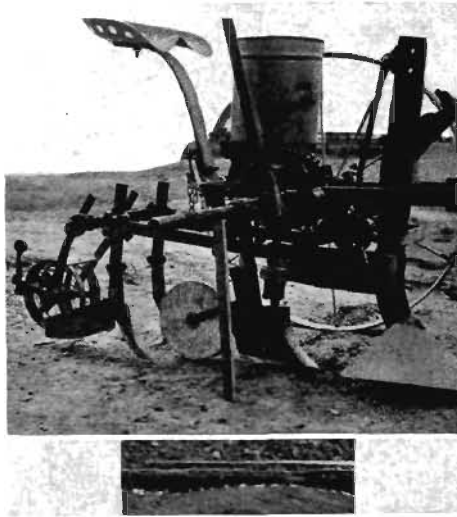


FIG. 237.—One-row riding cotton planter equipped with variable-depth attachment. The inset shows how the seeds are placed in shallow and deep cycles.

281. Variable-depth Attachment.—This is an attachment for planting seeds at a variable depth below the surface of the soil. The attachments, shown in Figs. 58 and 237, consist of a cam or crank to raise and lower the furrow opener as the planter is drawn along the row. The distance between the shallow and deep cycles is determined by the number of lobes on the cam or the length of the throw of the crank. Where the seed are drilled, some seed will be placed $1\frac{1}{2}$ to 2 inches deep and some only $\frac{1}{2}$ inch below the surface of the soil. Some seed will also fall on the slopes of the furrow sole between the deep and shallow cycles. Theoretically some of the seed should be placed in the soil at the optimum depth for good germination.

In Alabama, Randolph of the United States Department of Agriculture, Bureau of Agricultural Engineering, has secured better yields where cotton was planted at variable depths than at uniform depths. Tests

conducted by the author in Texas for a six-year period failed to show any significant difference in the two methods.

282. To Change from Cotton to Corn.—All cotton planters are equipped with hoppers so designed that the seed-dropping mechanism can be changed from cotton to corn or to sorghum by changing the equipment in the hopper bottom. Figure 238 shows the parts involved when changing from cotton to corn or the reverse in one make of planter.

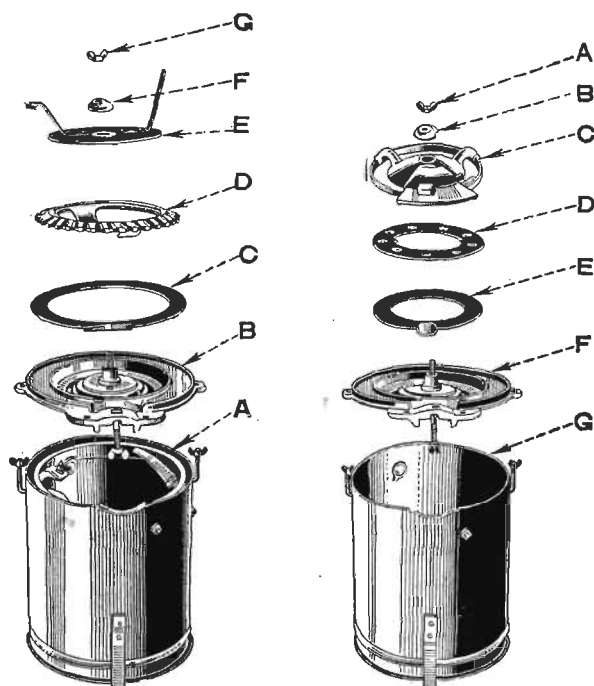


FIG. 238.—Parts involved in changing from cotton to corn or the reverse. Place the filler ring *A* in bottom of seed box. Put seed box bottom *B* on box and replace: *C*, filler ring; *D*, cotton plate; *E*, agitator plate; *F*, washer; *G*, thumb nut. Lift box bottom *F*, from box *G* and turn over and remove: *A*, thumb nut; *B*, washer; *C*, cut-off ring; *D*, corn plate; *E*, floor ring.

Other makes are slightly different. There are no valves in the seed spout or tube; hence, corn is always drilled with this type of planter.

283. Drive for Seed Plate.—The ratchets and pawls in the hubs of each wheel cause the axle to turn integral with the wheels. The spur or bevel gear on the axle transmits power to the plate gears which drive the plate.

284. The Variable Drop.—Most of the cell-drop planters are provided with a variable drop arrangement to vary the quantity of seed deposited. Some have several plates that may be changed. A common variable drop for cotton planters is shown in Fig. 239. It consists of a flat disk

gear with three rows of teeth. A movable-drive-pinion gear, when changed from one row of teeth to another, changes the speed of the seed

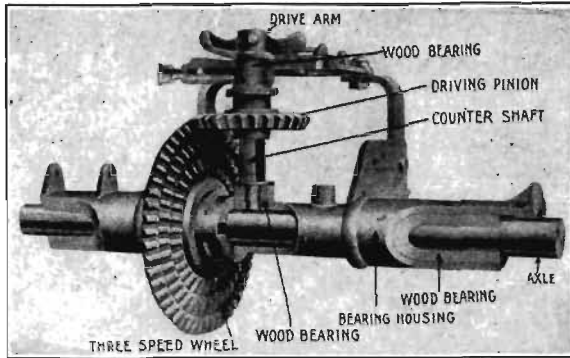


FIG. 239.—Flat-gear and movable-pinion type of variable drop for cotton and corn planters.

plate. If the outer row of teeth is used, the speed of the plate is increased and more seed deposited. The inner row gives a slower speed and less seed.

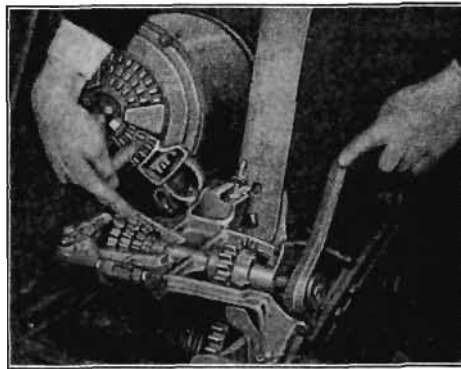


FIG. 240.—An easily operated type of variable drop for cotton and corn planters.

Another method is shown in Fig. 240. There are three bevel-pinion gears on the drive shaft and three rows of teeth on the plate gear of the hopper bottom. Only one of the three pinion gears can be engaged at a time. Any one of the three speeds can be obtained by shifting the lever which engages the pinion gears.

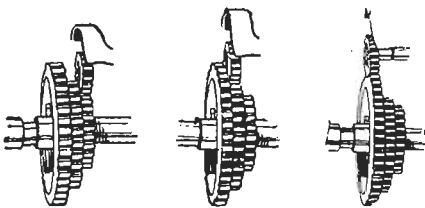


FIG. 241.—Spur-gear type of variable drop used on a cotton and corn planter.

Figure 241 shows a nest of three spur gears, cast integral, that slide on axle, allowing the spur gear on the hopper shaft to mesh with the gear, giving the desired speed.

285. Furrow Openers.—When planting cotton on beds, a large sweep is nearly always used in front of the regular seed furrow opener (Fig. 242).

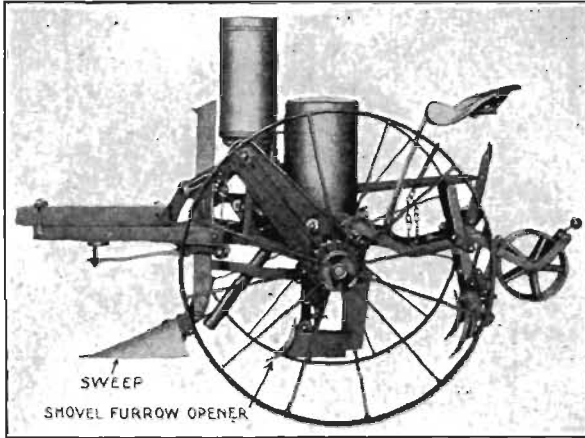


FIG. 242.—One-row cotton planter equipped with large sweep to knock off the top of the ridge.

This sweep is carried on a heavy, strongly built, and braced standard. The foot where the sweep is attached is adjustable to give the proper amount of suction. The sweep is used to shovel off the top of the ridges, leveling the ground somewhat, to destroy weeds, and provide a clean moist soil for the seed.

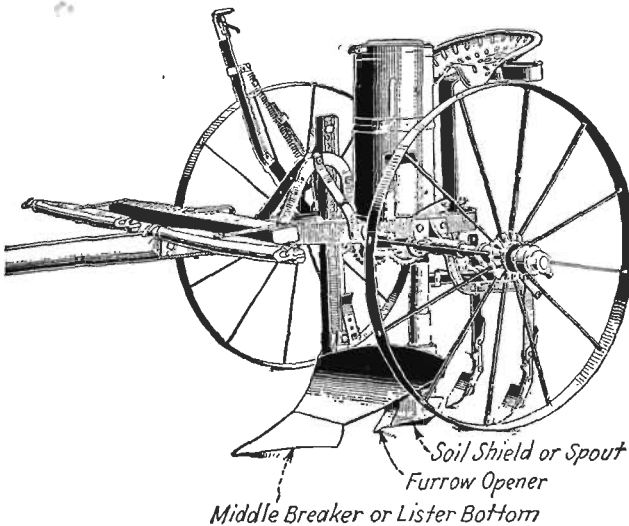


FIG. 243.—One-row riding cotton planter with middlebreaker furrow opener.

If planting in the listed or "water furrow," a middlebreaker bottom is substituted for the sweep (Fig. 243).

The regular seed furrow opener is carried to the rear of the standard and almost directly below the axle. In this position the seed tube or

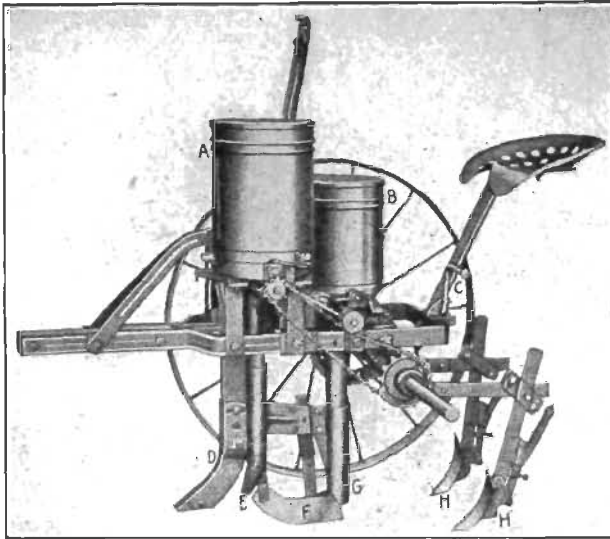


FIG. 244.—Cotton planter equipped with runner opener and fertilizer-distributing attachment: A, fertilizer hopper; B, seed hopper; C, foot lift for covering shovels; D, standard; E, fertilizer spout; F, runner furrow opener; G, seed spout; H, covering shovels.

seed spout is almost perpendicular. A furrow opener for the seed may be either a double-pointed, reversible shovel (Fig. 230), or a runner-shoe opener (Fig. 244). Shields are used with the shovel openers (Fig. 243) to prevent the soil falling back into the furrow before the seed are deposited.

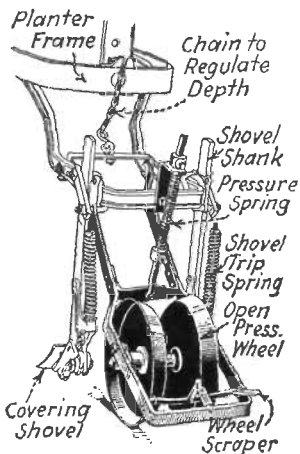


FIG. 245.—Covering frame showing spring trip-covering shovels and press wheel.

Both the sweep and the subopener are raised together. When they are raised, the seeding mechanism is automatically disengaged, either by lifting the seed box off the drive gears or by disengaging a clutch on the axle.

286. Covering Shovels.—The covering shovels are attached to a frame that works in conjunction with the raising of the standard. The covering shovels are raised and lowered with the furrow opener. The covering shovels, however, can be raised independently by means of a foot lever. Double-pointed and reversible shovels are attached to shanks that can be adjusted up and down and tilted forward or back to vary the suction of the shovels. The

shanks can be set either inside or outside the covering frame, and may be staggered to allow trash to work through. The covering shovels are equipped with either the spring trip, the pin break, or the friction trip.

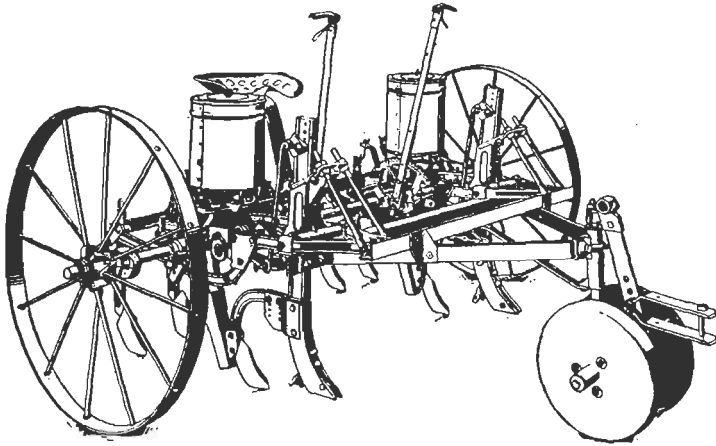


FIG. 246.—Two-row cotton and corn planter equipped with tongue truck.

A press-wheel attachment (Fig. 245) can be used behind the covering shovels if desired.

287. Special Attachments.—A fertilizer attachment can be attached or removed easily, as shown in Fig. 244. The fertilizer feeding mechanism

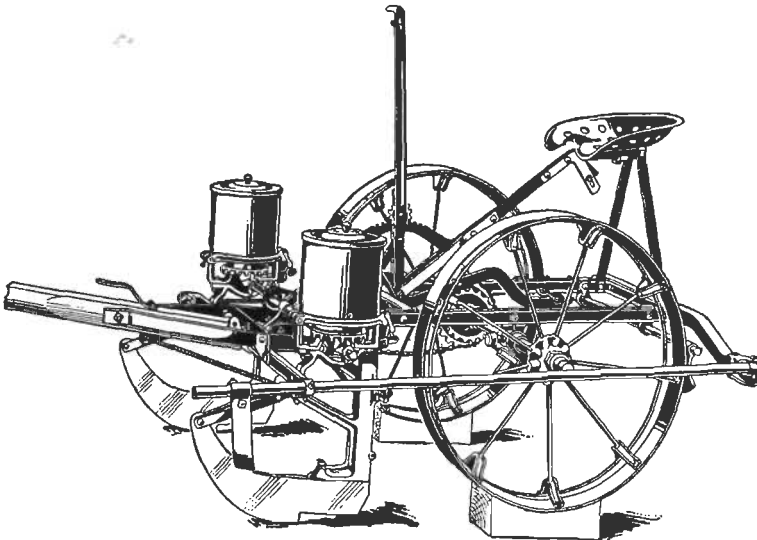


FIG. 247.—Two-row cotton and corn-drill planter of the check-row type.

is driven from the main axle by a chain and sprocket. A spout conducts the fertilizer to the ground just ahead of the seed furrow opener where it is mixed with the soil.

Special plates for planting kafir, milo maize, peas, and peanuts can be secured and used on all cotton and corn planters.

Press-wheel attachments, disk coverers, sweeps, and middlebreaker bottoms are all extra equipment, and can be obtained when desired.

288. Two-row Cotton Planter.—The two-row mule-drawn cotton planter shown in Fig. 246 is really two units of the one-row planter com-

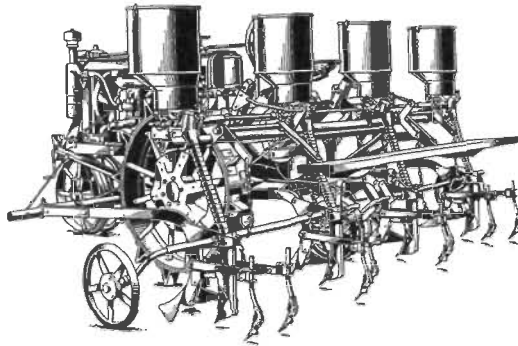


FIG. 248.—A four-row tractor-mounted cotton planter.

bined. One axle serves for both units. The distance between rows can be adjusted from 32 to 42 inches.

289. Two-row Cotton and Corn-drill Planters.—This type of cotton planter is built like the check-row planter (Fig. 247). The checking apparatus consisting of the valves, checking head, drop shaft, and wire is removed. All other parts of the planter are essentially the same as the corn drill.

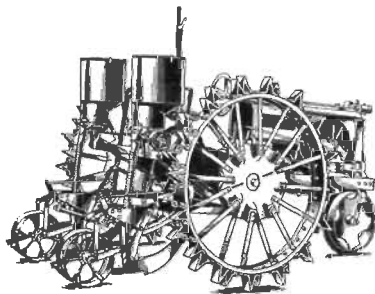


FIG. 249.—Two-row tractor planter equipped with runner openers and press wheels.

When care is used in spacing and building the beds for cotton, this type of planter can be used to a good advantage.

290. Tractor-mounted Cotton Planters.—When the general purpose or row-crop type of tractor was developed, two-row, three-row, and four-row planters were designed and mounted on them.

Many different arrangements have been tried, but the most popular style is shown in Fig. 248. Two-row and four-row types are available. Sweeps for knocking off the tops of the ridge are bolted to regular middlebreaker beams. The seed furrow opener and covering shovels are arranged behind the sweep in the same manner as they are on the horse-drawn planters. Gage wheels regulate the depth of the sweep and covering shovels. The large seed hoppers are mounted high enough above breaker beams to permit the

sweeps to be raised by means of a power lift. Long flexible seed tubes conduct the seed from the hopper into the boot.

Where planting is done in listed furrows, middlebreaker bottoms can be substituted for the sweeps.

Plates for planting corn and sorghum are furnished as regular equipment. Fertilizer attachments can be supplied if desired.

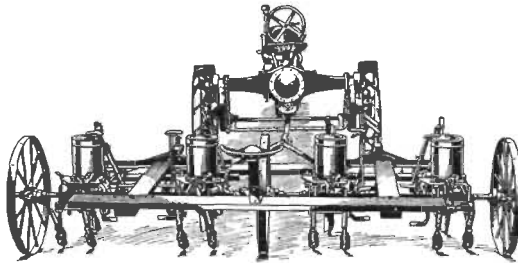


FIG. 250.—A four-row tractor planter composed of two two-row horse-drawn planters.

291. Duty of Cotton Planters.—With a one-row planter, either walking or riding, an average of 7 acres can usually be planted in a 10-hour day. Gabbard and Jones¹ found that a two-row horse-drawn planter will plant an average of 14.3 acres while a two-row tractor-drawn planter will plant 23.3 acres in a 10-hour day. A four-row tractor-drawn planter will plant an average of 35.7 acres in a 10-hour day.

292. Draft.—The one-row riding cotton and corn planter is usually drawn by two horses or mules. When listing or planting in heavy soils, three horses are often desirable.

¹ *Tex. Agr. Expt. Sta. Bull.* 362, p. 13, 1927.

CHAPTER XVIII

MISCELLANEOUS TYPES OF ROW PLANTERS

LISTER PLANTERS

The lister planter is especially suited to the subhumid regions. It is designed to open a furrow, drop, and cover the seed in the bottom of the furrow in one operation. Dropping mechanisms, suitable to plant most of the field-row crops can be obtained for any type. The different types of lister planters are:

- One-row walking.
- One-row two-wheel riding.
- One-row four-wheel riding.
- One-row wide-tread trench guide.
- Two-row horse or tractor.
- Three-row tractor.

293. One-row Walking Lister Planter.—As shown in Fig. 251, this planter consists of an ordinary walking middlebreaker with a planting mechanism attached on the rear. When disk coverers are used, the seed plates are driven by the disks. When shovel covers are used, steel wheels drive the plates.

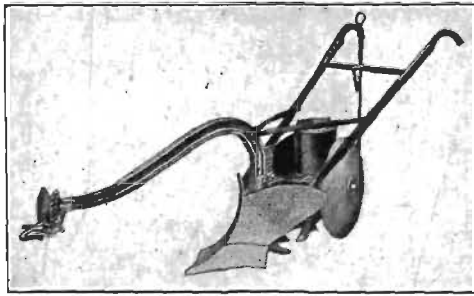


FIG. 251.—One-row walking lister planter.

294. One-row Two-wheel Lister Planter.—The one-row two-wheel lister planter is shown in Fig. 252. The beam, which carries the bottom, is attached to a bail-shaped axle, which in turn raises and lowers the bottom. The wheel boxes are in the form of long sleeves and the wheels can be set in or out for different widths of rows. The seed mechanism is driven by a chain receiving power from a sprocket on the sleeve of the wheel. The seat is located in front of the seed box, which makes it difficult

for the operator to watch the seeding mechanism. Disk coverers are regular equipment but shovels can be obtained if desired.

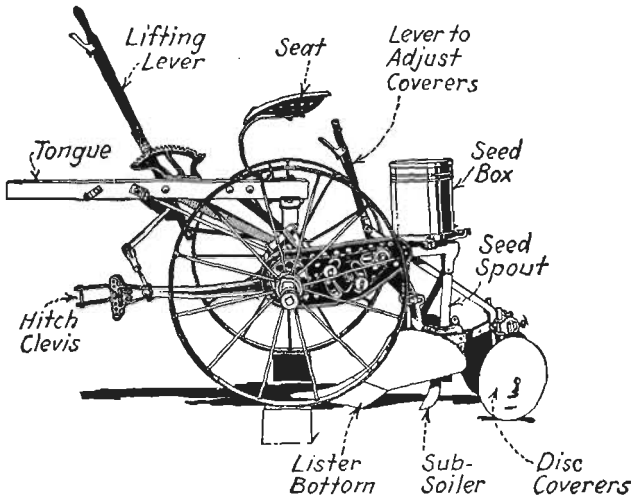


FIG. 252.—One-row two-wheel lister planter.

295. One-row Four-wheel Lister Planter.—Figure 253 shows how this planter differs from the two-wheel type. The bottom is carried on a frame which extends to the rear, being supported by two small wheels.

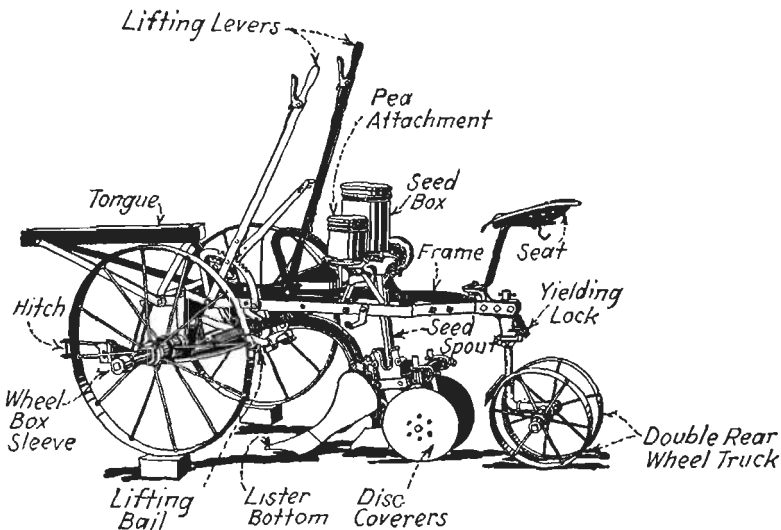


FIG. 253.—One-row four-wheel lister planter.

The rear wheels lock and hold the planter steady while planting but release and castor when turning. They also act as press wheels. The

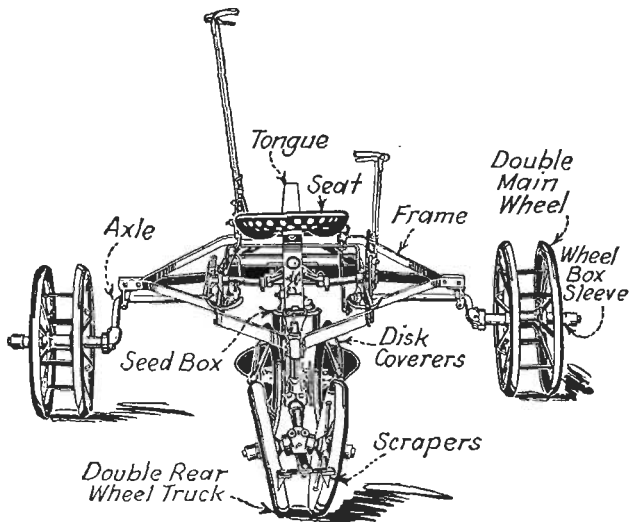


FIG. 254.—One-row wide-tread trench-guide lister planter.

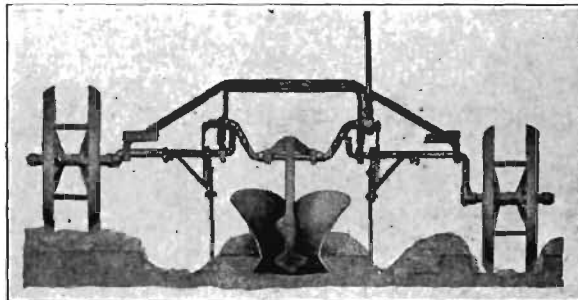


FIG. 255.—A wide-tread lister planter with seed mechanism removed, showing how the planter is used and controlled. It is shown in position for double listing.

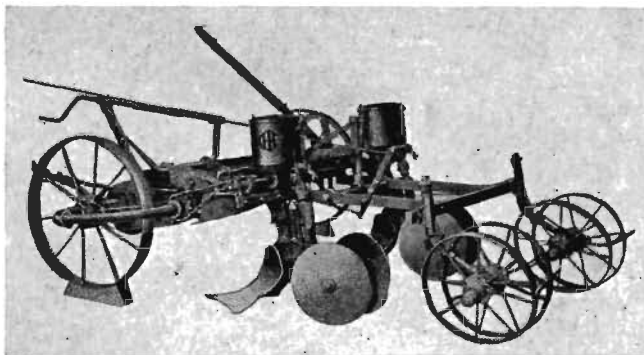


FIG. 256.—Two-row lister planter suitable for either horses or tractors.

front wheels can be set in or out on long wheel-box sleeves. The seed mechanism is chain driven by power transmitted from one of the front wheels. The seat is placed to the rear of the seed box allowing the operator to watch the planting. Disk or shovel coverers are furnished.

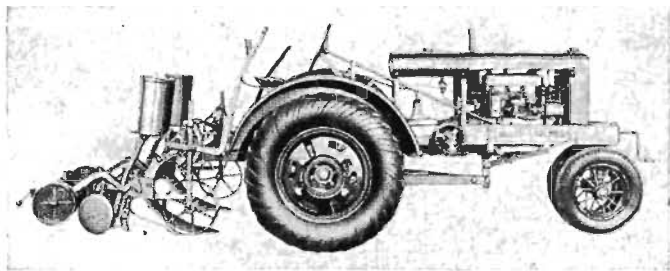


FIG. 257.—Two-row tractor lister planter.

296. One-row Wide-tread Trench-guide Lister Planter.—The main wheels are set far enough apart to allow the wheel on either side to run in the bottom of the last row listed and planted. Figure 254 shows the complete planter, while Fig. 255 shows how it is used and controlled.

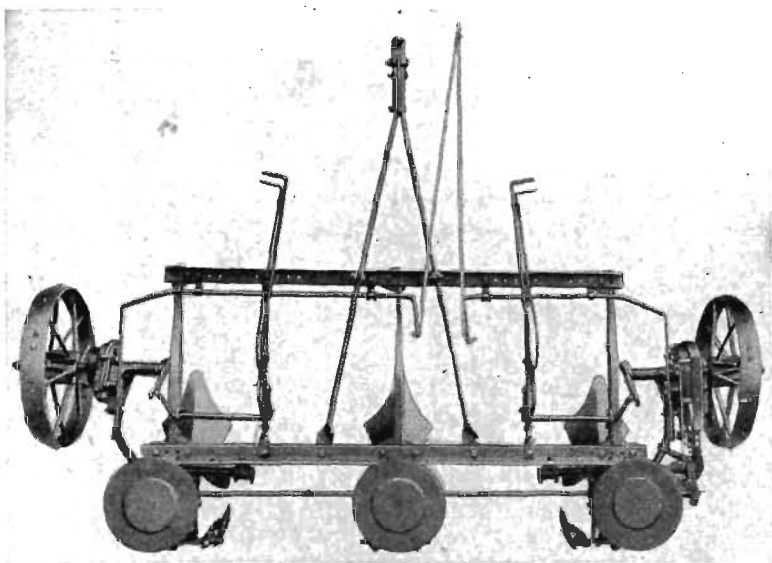


FIG. 258.—Three-row tractor lister planter equipped with power lift.

The rows are uniformly spaced and parallel. The main wheels are double, with the two rims set far enough apart to fit in the bottom of the trench. Some wide-tread planters have the frame spread wide as in Fig. 254; while others make the wheel-box sleeves longer. In the former

the seed mechanism is driven by the covering disks, while in the latter it is driven by a chain from one of the wheels.

297. Two-row Lister Planter.—The two-row lister planter, as shown in Fig. 256, is adaptable to either horses or tractors. The planter is two units of the four-wheel type combined and equipped with stronger frame, wheels, and a power lift.

A number of two-row lister-planter attachments for tractors have been developed.

298. Three-row Tractor Lister Planter.—Three-row machinery is relatively a recent development. A three-row lister planter used with a tractor is shown in Fig. 258.

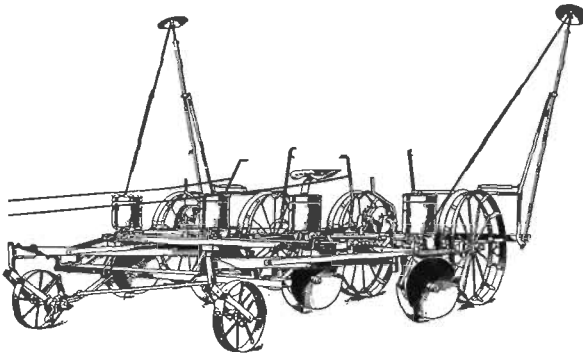


FIG. 259.—Four-row loose-ground lister planter composed of two two-row horse-drawn planters.

299. Loose-ground Lister Planter.—When the check-row type of planter is equipped with large double-disk furrow openers, it is considered as a loose-ground lister planter (Fig. 259).

POTATO PLANTERS

In the production of potatoes on a commercial scale, it is necessary to reduce the cost of production as much as possible by the use of machinery. There are a number of successful potato planters on the market which may be classified as the one-man or picker type and the two-man or platform type.

300. One-man or Picker Potato Planter.—The dropping mechanism (Fig. 260) consists of three to six arms attached to a vertical revolving disk; on the ends of the arms are spikelets, forks, or pickers (Fig. 261) that pick the set out of the hopper. As the pickers move through the hopper, each picker spears or stabs a seed potato and carries it over to the front of the machine where the set is punched off by a special ejector into the seed spout. The distance between hills can be regulated by the number and speed of the pickers. Stub-runner furrow openers are usually used; however, single- or double-disk openers can be obtained.

Disk coverers are raised and lowered automatically with the furrow opener. The planting mechanism is disengaged at the same time.

The advantages of this type are that one man can operate either the one-row or the two-row machine, thus saving expense and labor.

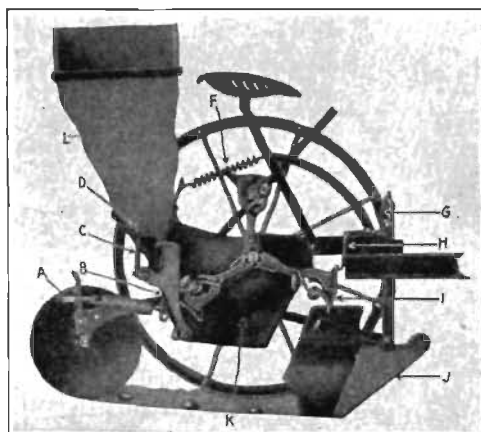


FIG. 260.—Sectional view of dropping mechanism of one-man type potato planter: A, disk coverer; B, concave; C, concave tension spring; D, concave-spring-adjusting nut; E, coverer spring; F, agitator spring; G, lifting handle; H, tripper; I, picker; J, furrow opener; K, magazine; L, canvas-sack hopper.

The disadvantages are: The pickers may spread disease; they make 5 to 20 per cent misses,¹ while, on the other hand, they may frequently take two pieces of potato instead of one.



FIG. 261.—Picker potato-planter dropping mechanism: A, complete picker head; B, picking hand.

301. Two-man or Platform Type of Potato Planter.—The dropping mechanism in this type of planter is entirely different from that of the picker type. It consists of a device to elevate the seed piece from the hopper to the horizontally revolving platform, having compartments or

¹ *Mich. Special Bull.* 117, 1922.

pockets (Figs. 262 and 263), which carries the piece to the opening over the seed spout through which it falls into the furrow. The seed piece is elevated by a chain equipped with cups or a sprocket-like wheel

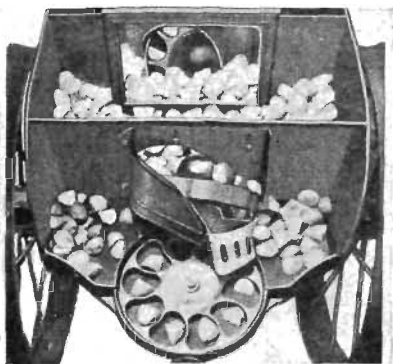


FIG. 262.—Feeding mechanism of platform or two-man type of potato planter. The feed on the inside of the hopper is reflected by the mirror.



FIG. 263.—The duty of the extra man on this potato planter is to prevent misses by filling the empty pockets on the platform.

(Fig. 262). Should the elevating device fail to place a seed piece in each pocket, it is the duty of the extra man to fill the pocket. If two pieces are placed in one pocket the man can remove one of them. If properly handled, this type of planter will make less than 1 per cent of misses.

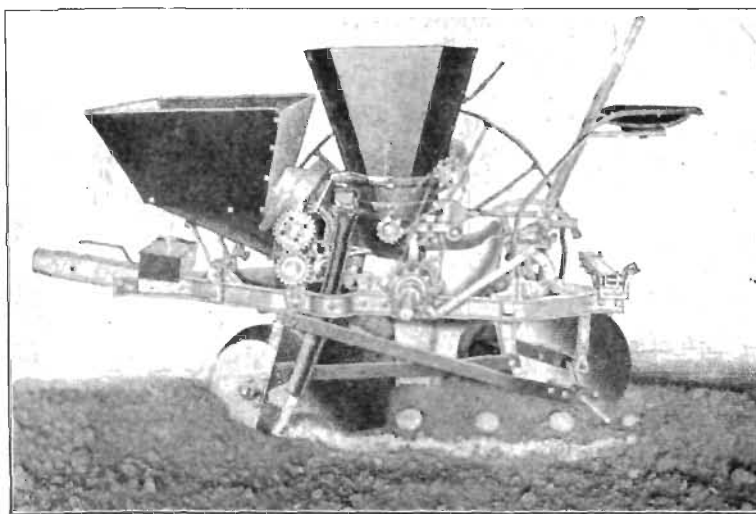


FIG. 264.—Potato planter with wheel and parts removed to show how fertilizer and potato-seed pieces are dropped.

Stub-runner furrow openers and disk coverers are used.

302. Fertilizer Attachments.—Fertilizer attachments may be used with most of the potato planters. The fertilizer is fed into steel tubes

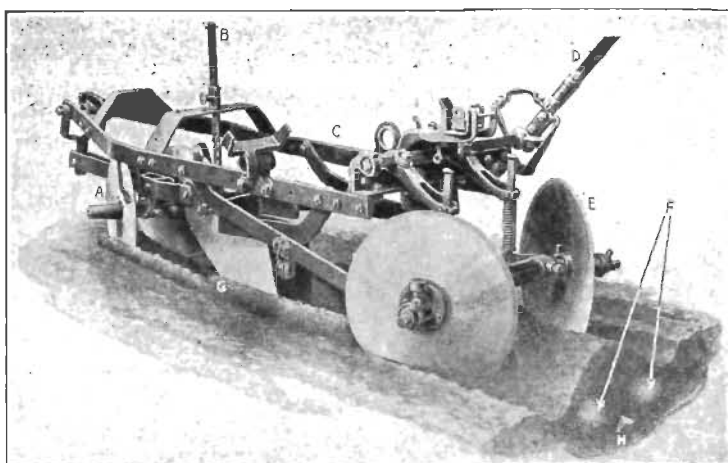


FIG. 265.—Frame, furrow openers, and covers for potato planter: A, fertilizer furrow opener; B, depth adjuster; C, frame; D, lifting lever; E, disk covers; F, fertilizer; G, potato furrow opener; H, potato piece.



FIG. 266.—Two-row potato planter equipped with rubber tires drawn by a rubber-tired tractor.

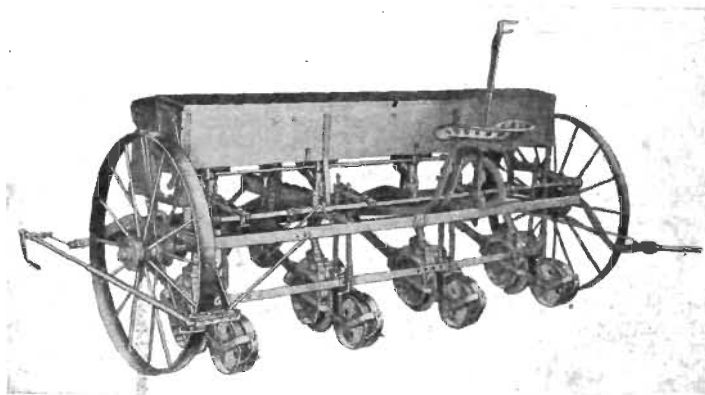


FIG. 267.—Rear view of fertilizer beet drill.

which convey it to both sides and in front of the furrow opener where it is deposited in the furrow and on the ridge left by the double disks in such a manner that, as the furrow opener splits this ridge, the fertilizer is mixed with the soil. Figures 264 and 265 show the parts performing these various operations.

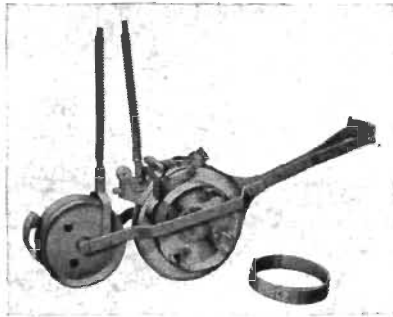


FIG. 268.—Disk furrow opener for beet drill. Note the band for regulating depth of planting.

BEET AND BEAN PLANTERS

Where beets, beans, and other vegetable crops are grown on a commercial scale, special planters are desirable. A four-row planter designed especially for planting of such crops is shown in Fig. 267. Adjustments can be made on most planters from 16 to 28 inches at each 2-inch interval.

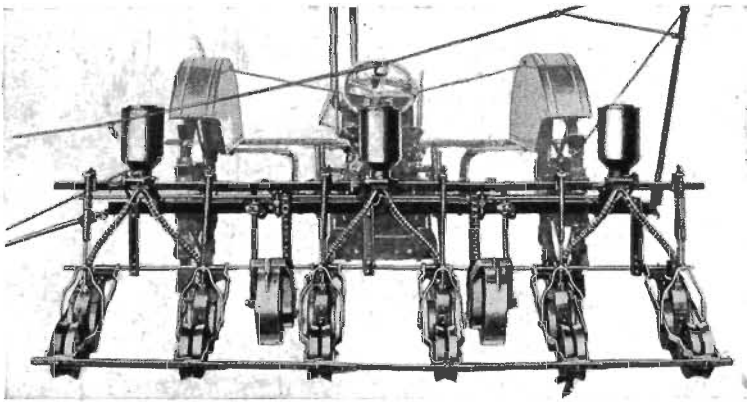


FIG. 269.—Rear view of six-row tractor mounted beet and bean planter.

Runner or disk furrow openers with press wheels can be obtained. Fertilizer attachments and row markers can also be furnished.

To plant at a uniform depth it is essential that the ground be smooth and firm and the furrow openers be set on the same level.

TRANSPLANTING MACHINES

Where large quantities of plants, such as cabbage and sweet potatoes, are to be transplanted, time and labor can be saved by the use of a transplanting machine (Fig. 270). These machines have a device to open a small furrow, a tank for the supply of water, and disks or blades for closing the soil about the plants. With a transplanting machine

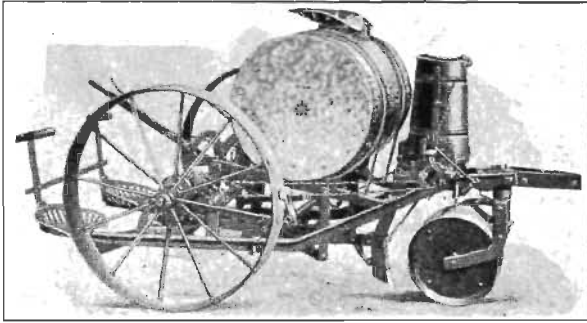


FIG. 270.—Transplanter with fertilizer attachment.

it is not necessary to wait for a *season* as the machine automatically pours a small quantity of water around the roots of each plant as it is being set. Under favorable conditions with a one-row machine 3 to 4 acres of land can be set to plants per day.

CHAPTER XIX

SEEDING MACHINERY FOR SMALL GRAINS

The most satisfactory method of sowing any of the small grains is with the grain drill. The largest yields are obtained from fields where

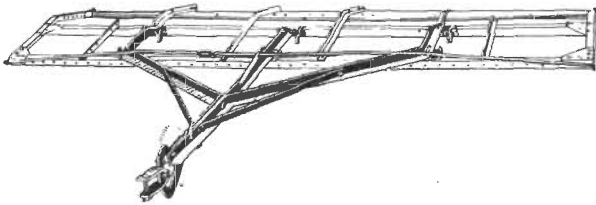


FIG. 271.—Frame for a grain drill.

the seed have been deposited evenly and in the right amount in a firm, compact soil and covered at a uniform depth. It is practically impossible to secure these conditions when the seed are sown with a broadcast seeder.

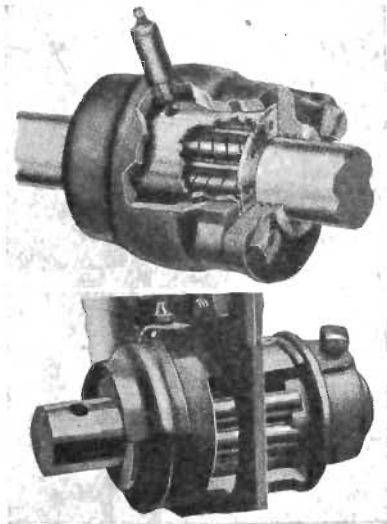


FIG. 272.—Bearings for grain drill.

GRAIN DRILLS

In general, grain drills may be classed as horse-drawn and tractor-drawn drills. Horse-drawn drills are divided into the regular field drill and the one-horse drill. The field drill may be referred to in accordance with the type of furrow opener and seed box used on the drill.

303. Frame.—The frame is usually made of angle steel, well braced and reinforced at the corners (Fig. 271). It is necessary that the frame be strong enough to prevent sagging and to hold parts in alignment, as all parts are connected to the frame. The axle is carried beneath, with the wheels on each end of it. The seed box is carried above, while the furrow openers are suspended below. Roller bearings are usually used on each end of the axle (Fig. 272).

304. Wheels.—The wheels found on grain drills may be made of wood or steel. Some planters prefer one and some the other. For some parts

of the country wooden wheels are preferred but they have the disadvantage of wearing out quickly; on the other hand, they do not slip so easily on hillsides and do not pick up loose dirt and soil and drop it on

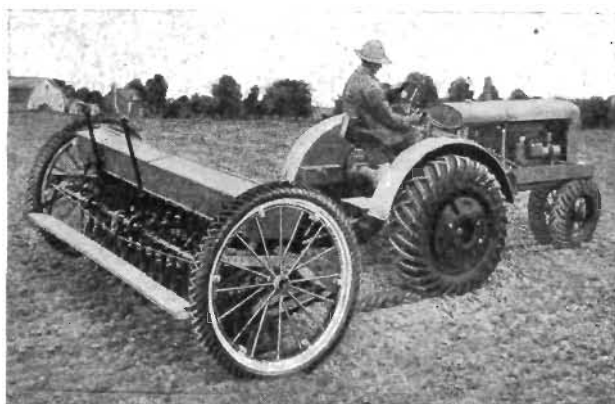


FIG. 273.—Grain drill equipped with rubber tires.

the exposed gears. Most drills sold in the Southwest are equipped with steel wheels because of the climatic conditions which affect wooden wheels. Figure 273 shows a grain drill equipped with rubber tires.

In the hubs of the wheels are ratchets and pawls to afford a means of transmitting the power from the hub of the wheel to the axle and, at the same time, allow turning where it is necessary that one wheel remain stationary and the other turn. It is essential that the pawls engage the ratchet immediately after the grain drill is moved forward. If the wheels can be revolved any distance without the pawls engaging immediately, bare strips will be left in the field.

305. Seed Box.—The seed box should be well braced and built rigid. The end of the box is shaped somewhat similar to a trapezoid (Fig. 274). The box tapers from the top, allowing the seed to flow directly into the feed cup. When the box has a partition running lengthwise through it, the front section for grain and the rear section for fertilizer, it is termed a *fertilizer drill*. Otherwise, it is a *plain drill*. Agitators are provided to prevent the grain *bridging over* in the box. They may be single or double rods. Figure 275 shows a double-rod agitator. The grain feeds are in the bottom of the box. There are two types of grain feeds: the fluted-wheel and the internal double-run force feed.



FIG. 274.—Steel seed box for grain drills.

306. The Fluted-wheel Feed. --The fluted-wheel feed is considered the simpler of the two feeds. It is also more generally used. It consists mainly of a fluted-wheel feed roll, feed cutoff, and an adjustable gate.

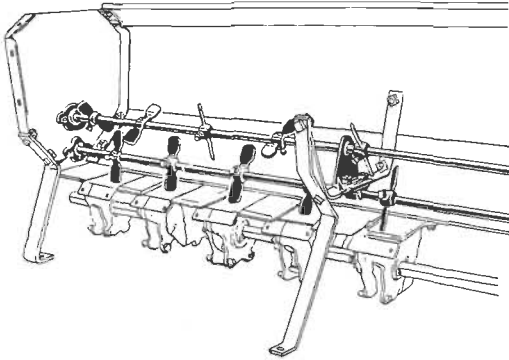


FIG. 275.—Double-rod agitator.

Figure 276 shows that the feed roll and the cut-off are mounted on a square shaft running through the feed cups. The feed roll turns with

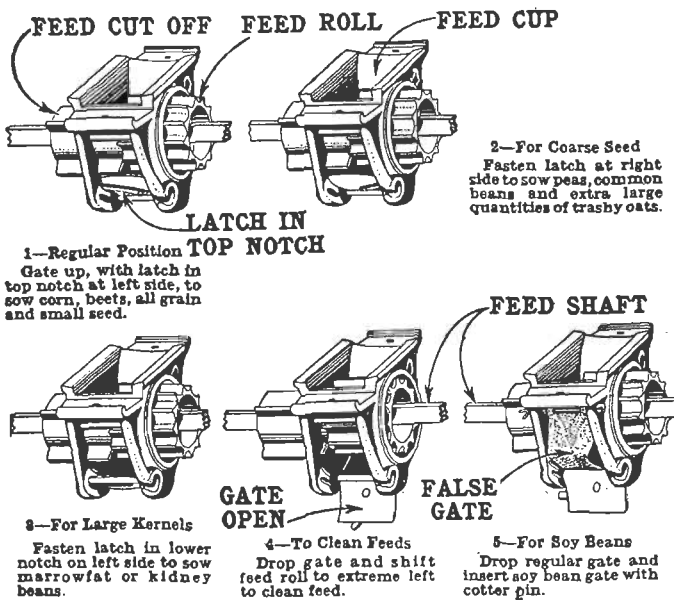


FIG. 276.—Fluted-wheel grain feed showing the various adjustments.

the shaft, forcing the grain out over the gate where it falls into the seed tube. The gate is adjustable for different size seeds.

Power is transmitted from the main axle to the feed shaft by gears or sprockets and chains.

The quantity of seed sown per acre is varied by exposing more or less of the feed roll to the seed inside of the feed cup and by adjusting the gate. Figure 277 shows a typical indicator plate used to adjust the fluted feed roll to sow the desired quantity per acre. The various adjustments of the fluted wheel are shown in Fig. 276.

307. The Internal Double-run Force Feed.—This feed shown in Fig. 278 gets its name from its construction. It consists of a double-faced wheel having a small and a large side. The small side is used for planting small seeds while the large side is used for planting larger seeds such as oats, wheat, peas, and beans. Figure 278 shows one side covered while the other is in use. The lid is hinged over the middle of the wheel so it can be reversed to cover either side.

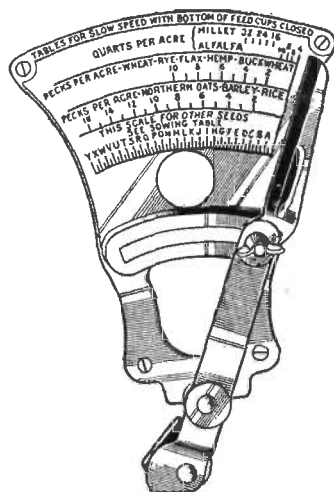


FIG. 277.—Quantity-feed dial indicator for fluted-wheel grain feed.

The quantity of seed sown per acre is varied by varying the speed of the feed wheels. Figure 279 shows an arrangement for changing the



FIG. 278.—Internal double-run force-feed grain feed; left cover on right or large side; right cover on left or small side.

speed. Special attachments to reduce the size of the outlets and adjustable gates also aid in regulating the quantity of seed sown per acre.

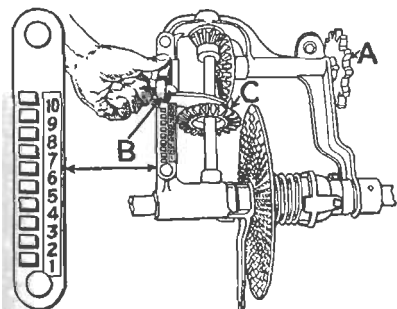


FIG. 279.—Method of varying the quantity of seed sown per acre with the internal double-run feed.

flow of grain through it.

308. Seed Tubes.—Seed tubes are provided to conduct the seed from the feed cup down through the boot and furrow opener into the furrow.

The most common type of seed tube is the steel ribbon shown in Fig. 280. Being rolled with the lower edge slightly thinner than the upper edge makes the tube collapsible to half its normal length without diminishing the inside diameter or retarding the even

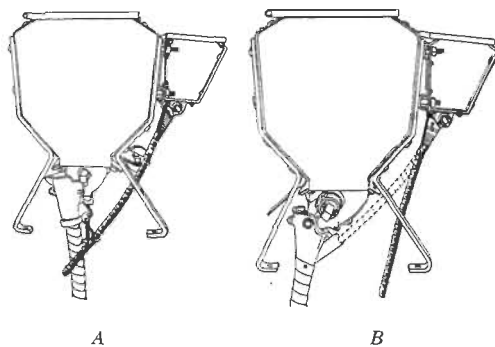


FIG. 280. Seed box showing grass-seed attachment: *A*, shows grass-seed tube arranged to sow behind grain; *B*, shows tube for sowing grass seed either ahead or with the grain.

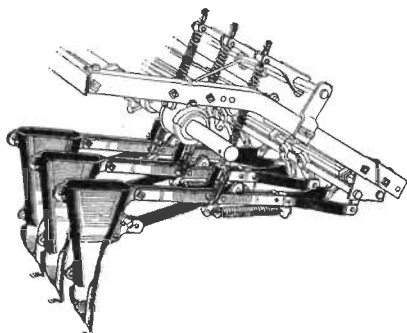


FIG. 281.—Hoe-type furrow opener.

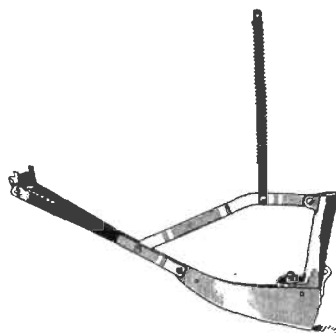


FIG. 282.—Shoe-type furrow opener.

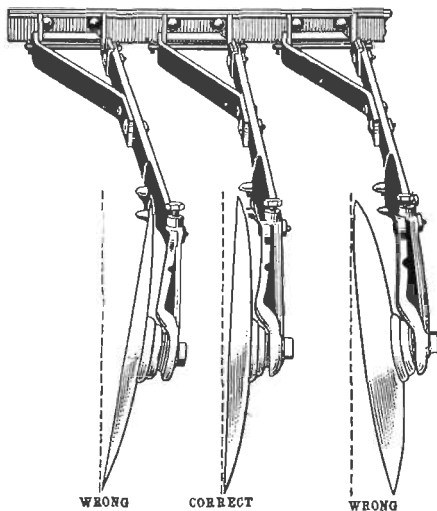


FIG. 283.

FIG. 283.—Single-disk furrow opener.

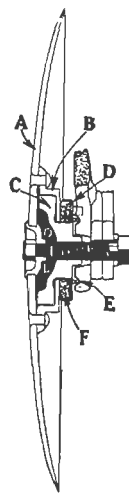


FIG. 284.

FIG. 284.—Cross-section of drill disk showing bearing: *A*, disk blade; *B*, disk-bearing case; *C*, disk bearing; *D*, felt washer; *E*, steel dust cap; *F*, dust-cap spring.

Other kinds of seed tubes are the steel wire, the rubber, and the telescope.

Figure 280 shows how the grass-seed tube is attached to the regular seed tube.

When fertilizer is being distributed it may also pass down the regular grain-seed tube.

309. Boot.—The boot is the hollow casting into which the lower end of the seed tube extends and to which the furrow openers are attached (Fig. 288).

310. Furrow Openers.—There are four types of furrow openers used on grain drills: the hoe, shoe, single, and double disk.

The *hoe* furrow opener shown in Fig. 281 consists of a single- or double-pointed shovel fastened to the lower part of the boot. The grain drops into the furrow directly back of the shovel. A spring or pin trip is provided so that when a hoe strikes an obstruction, no damage is done. This type of opener often gives trouble by clogging up when used in trashy ground.

The *shoe* furrow opener (Fig. 282) is made from two flat pieces of steel welded together to make a cutting edge similar to the curved-runner opener used on corn planters.

Single-disk furrow openers consist of one disk slightly dished and securely fastened to the boot and set to run at a slight angle (Fig. 283). The seed are dropped from the boot on the convex side of the disk at a point below and to the rear of the center. A toe scraper is used on the convex side and a tee scraper on the concave side to keep the disk clean.

The single-disk opener gives good penetration, cuts trash well, and does not easily clog.

Half of the openers are assembled with the concave side facing the right and half to the left. Penetration is aided by spring pressure. They may also be set staggered or in a straight line.

Since the disks revolve, they must be provided with bearings that are well designed, constructed, and lubricated. Figure 284 shows a cross-section of the various parts of a well-designed disk bearing.

Figure 283 shows the correct and wrong way to set single-disk furrow openers.

A *double-disk opener* is composed of two disks, having very little dish, set facing each other at a slight angle so as to form a bevel-cutting edge where they penetrate the soil. In this position the disks open a clean

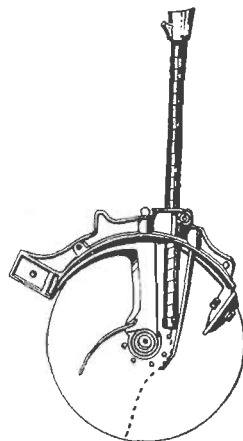


FIG. 285. View of double-disk opener with one disk removed to show how seed is protected between disk until it reaches the open furrow.

furrow and leave a small ridge in the center so that, when the seed are deposited in the furrow, there is a tendency to make two distinct rows about 1 inch apart. A cutaway view of a double-disk furrow opener is shown in Fig. 285. The seed are protected while passing between the disks until they reach the bottom of the furrow.

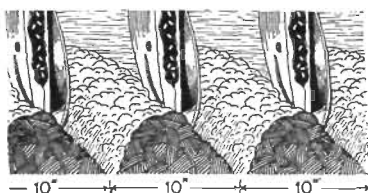


FIG. 286.—Single-disk deep-furrow opener and type of furrow made.

Lister or deep-furrow openers are shown in Figs. 286 and 287.

311. Covering Devices.—The most common type of covering device is the drag chain. Figure 288 shows how it is hooked to the boot and how it drags over the furrows to cover the seed without packing the soil.

In the subhumid regions where the soil is dry and where the soil is liable to blow, press wheels are used to cover the seed and press the soil around them. Figure 289 shows a drill equipped with large press wheels. The regular wheels are replaced by the press wheels. The latter also drive the seeding mechanism. Small gang press wheels (Fig. 290) also may be obtained.

312. Size of Drill.—The size of a grain drill is determined by the number of furrow openers and the distance they are spaced apart. The size is expressed as 18 by 7 which means there are 18 furrow openers spaced 7 inches apart. Drills can be secured with the feeds and furrow openers spaced either 6, 7, or 8 inches apart.

313. Land Measures.—Grain drills are all equipped with a small device, similar to the one shown in Fig. 291, which is called a *land measure* or a *surveyor*. This is an instrument which is so designed that it determines the number of acres sown. If the operator will keep a record of the number of bushels placed in the seed box and the number of acres sown, a check can be made as to the accuracy of the drill in the amount of seed being sown per acre. This is *not* termed *calibration*.

314. Calibration of Grain Drills. Many grain drills do not sow accurately, even though the indicator on the dial plate is set correctly. Some will sow more seed than the dial indicates, while others will sow less

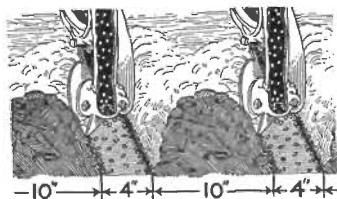
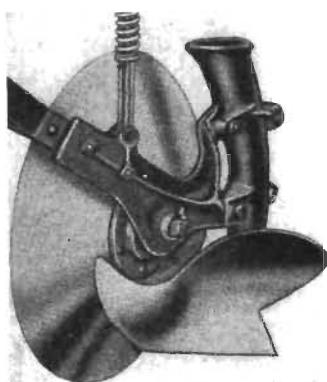


FIG. 287.—New-style lister furrow opener and type of furrow made.

Oftentimes the operator will attempt to check the drill in the field by measuring off a certain acreage, seeding it, and, then, determining the

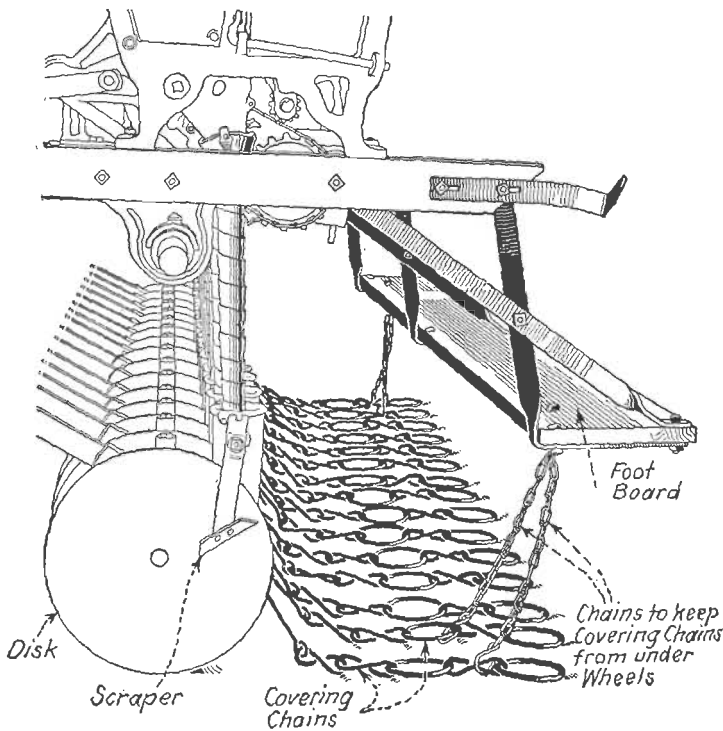


FIG. 288.—Footboard and covering chains.

amount of seed sown. At best, this is a very poor method of checking a drill.

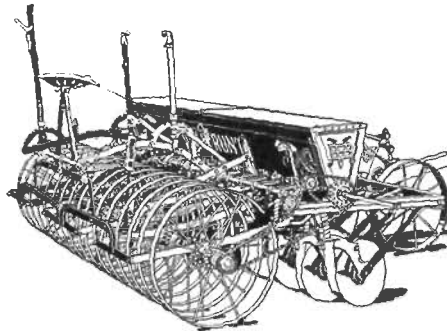


FIG. 289.—Grain drill equipped with large press wheels, grass-seed attachment and tongue truck.

The method of calibrating a drill is as follows: First, find the width of the strip the drill will sow. Measure the distance between furrow

openers and multiply it by the number on the drill. Next, find the length of the strip of that width necessary to make 1 acre. This is done by dividing 43,560—the number of square feet in 1 acre—by the width of the strip sown by the drill. The result will be the distance the drill must travel to sow 1 acre of grain.

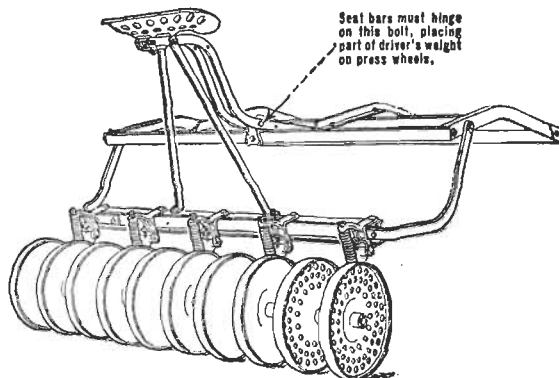


FIG. 290.—Small press wheels.

Now, find the number of times the wheels on the drill will turn in going this distance by dividing the distance to be traveled by the circumference of the wheel.

Fill the seed box with grain.

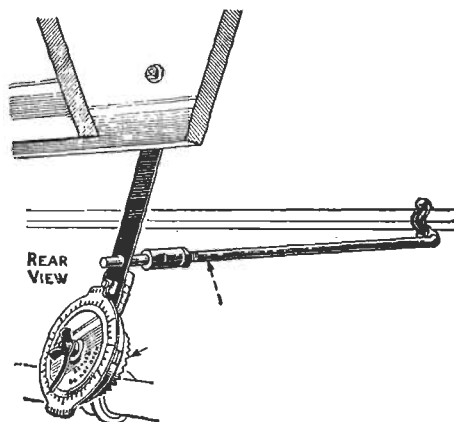


FIG. 291.—Land-measuring device.

Set indicator on the scale to sow whatever quantity of seed is desired.

Jack up the drill and place a paper bag under each seed tube. Tie a rag around each tire so each revolution of each wheel can be counted.

Engage the clutch and turn the wheels, counting each revolution. Turn them about the same speed they would travel in the field. When the wheels have been turned the equivalent of $\frac{1}{4}$ or $\frac{1}{2}$ acre, the grain

is collected and weighed. The weight of grain sown by each feed should be recorded separately so each feed cup can be checked. The amount is multiplied by 4 if $\frac{1}{4}$ acre was selected, and by 2 if $\frac{1}{2}$ acre was sown to figure on an acre basis.

If what is used and the indicator is set to sow 8 pecks, 8 pecks should have also been collected. If only 6 pecks of grain are collected the drill is in error.

The percentage of error of the indicated quantity is calculated by dividing the difference between the quantity collected and the quantity the indicator was set on by the indicated quantity.

315. Furrow-opener Lifts.—The furrow openers are lifted either by hand levers or by power-lifting devices. If by hand, there is one lever provided for each half of the furrow openers. When the drill is large and drawn by a tractor, power lifts (Fig. 292) similar to those used on plows make it possible for the tractor operator to raise and lower the furrow openers by simply pulling a rope to engage the clutch.

316. Tractor Hitches.—Where the ground is level and the acreage to be seeded is large, several grain drills may be arranged in such a manner that they all can be hitched to one tractor. One drill is usually hitched directly behind the tractor; then, with a special designed hitch, shown in Fig. 293, other drills are hitched to each side. As many as five large drills may be hitched to the same tractor.

317. Grass-seed Attachment.—A grass-seeding attachment can be secured for all grain drills. When used, it is attached in front of the main seed box, as shown in Fig. 280. The fluted-wheel type of feed is used in the feed cups. The seed tubes either empty directly into the regular grain-seed tube or they may be clamped to the side and let the grass seed fall behind the furrow openers.

318. Fertilizer Attachments.—When a fertilizer attachment is used the drill is usually known as a *fertilizer drill*, even though it is equipped with the regular grain-sowing feeds. Figure 295 shows a cross-section of a fertilizer drill. The feed for distributing the fertilizer is shown in detail in Fig. 296 and is the same as will be described under Fertilizer Machinery. The regular grain-seed tube serves as a spout to conduct the fertilizer down to the soil and prevents the wind blowing part of it away.

319. One-horse Drill.—It is often desirable to sow some of the small grains, peas, or soybeans between the rows of growing crops at the

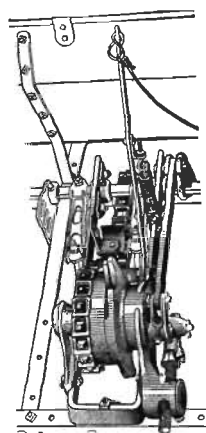


FIG 292. —
Power lift for grain-
drill furrow openers.

last cultivation. A special type of drill for doing such work has been made in the form of the one-horse five-hole drill shown in Fig. 298. It

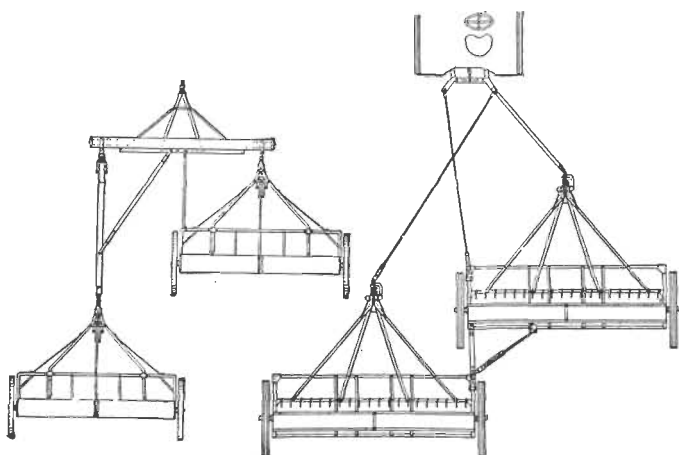


FIG. 293.—Two types of two-drill tractor hitches.



FIG. 294.—Tractor grain drill equipped with 28 furrow openers. Note the swath markers.

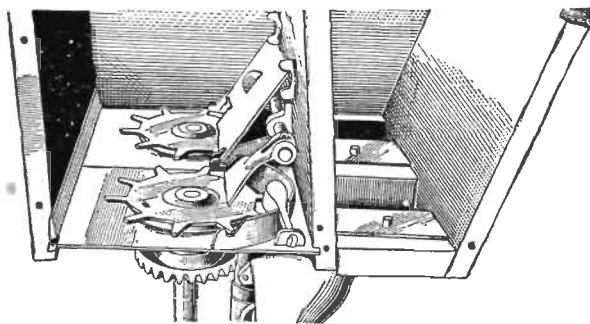


FIG. 295.—Cross-section of fertilizer drill showing grain and fertilizer feeds.

is a rather short narrow machine having a seed box, steel wheels, and furrow openers on the same principle as that of the regular type. The

weight of the machine is carried on a large wheel in front and two small ones behind. The large wheel in front acts as a drive wheel transmitting power to the grain feeds by means of a chain and sprocket. Handles

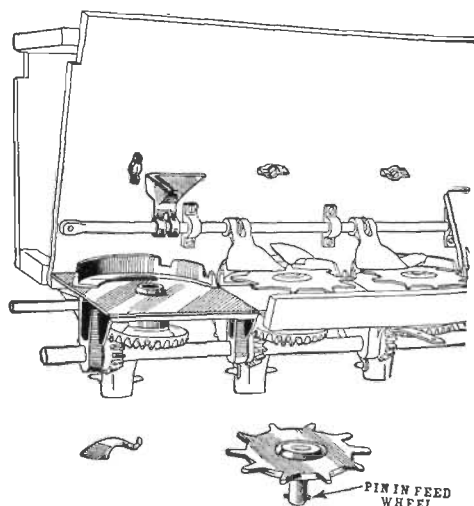


FIG. 296.—Fertilizer feed.

are provided for the operator to guide the machine. Grass-seed and fertilizer attachments may be secured on these machines.

320. Alfalfa Drill.—Alfalfa and grass seed are sown in rows closer together than the average grain drill will sow them. A special drill having furrow openers 4 inches apart is now being made. This makes an excellent drill for sowing alfalfa, clover, red top, timothy, blue grass, rape, sudan grass, millet, flax, and hemp. These different seeds can be planted in a large variety of quantities to the acre. There is no great difference between the alfalfa and regular drills other than that the feed cups and furrow openers are placed closer together on the alfalfa drills. The feed wheels are the internal, double-run, force-feed type and are made smaller than those on the regular drills. In some types of drills the speed of the grain feeds is changed by an arrangement of spur gears.

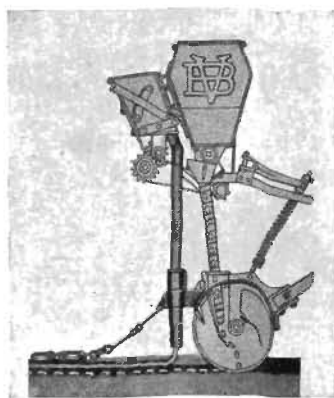


FIG. 297.—Fertilizer attachment placing fertilizer above seed.

321. Draft of Grain Drills.—Kranich¹ states that the draft of a plain drill will average around 6 pounds per furrow opener per inch of depth.

¹ KRANICH, F. N. G., "Farm Equipment," The Macmillan Company, New York, 1923.

The kind of seed being sown, the quantity in the seed box, the depth of seeding, the type of soil and its moisture content, the grade, and the condition of the drill are important factors that will influence the draft of a grain drill.

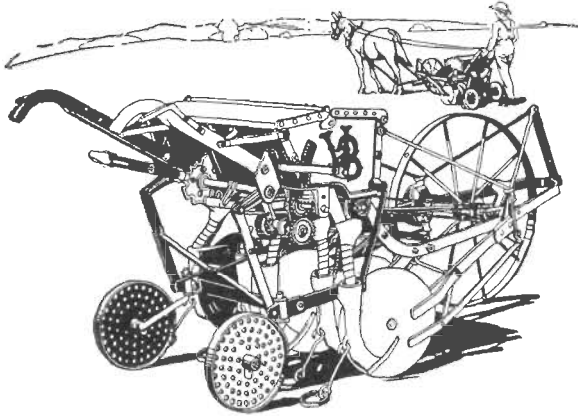


FIG. 298.—One-horse five-hole drill.

BROADCASTERS

Broadcasting is the oldest and simplest method of sowing seed. When the sower went forth to sow, in the time of our Savior, he carried

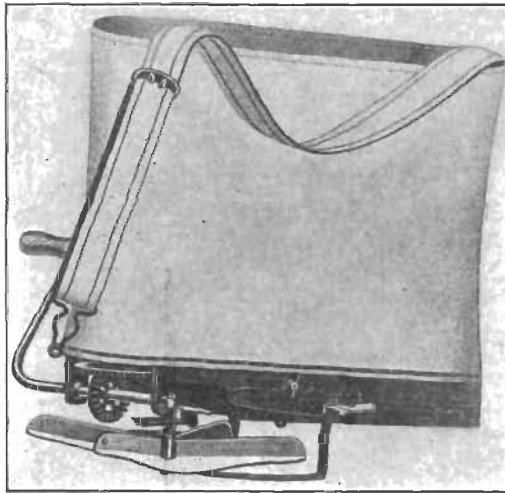


FIG. 299.—Knapsack broadcast seeder.

seed in a bag and broadcasted them by hand. Broadcasting with a machine is more accurate and rapid than when done by hand. Types of machine broadcasters are the knapsack, end-gate, two-wheel, and wheelbarrow.

322. Knapsack.—This seeder consists of a good-sized canvas sack fastened to a seeding mechanism, the whole being slung over the shoulders (Fig. 299). A crank turned by hand revolves a wheel having several different radial ribs for scattering the seeds. The ribs throw the seeds out to the front and sides in a steady stream. The quantity of seed is regulated by a sliding gate. The wider the gate is opened the more seed per acre will be sown. This type of seeder is good for sowing clover seed and small grass seed on lawns and fields in the early spring. Other types of knapsack seeders may have the wheel for scattering the seed placed in a vertical plane in front of the seeder. Still others, instead of having one wheel placed in a horizontal plane, may have two wheels, turning in opposite directions, placed opposite each other. The seeds are dropped on the inner sides and thrown to the front and sides.

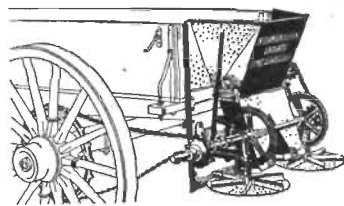


FIG. 300.—End-gate broadcast seeder.

323. End-gate Seeder.—The end gate is an attachment that is placed on the rear end of a wagon box (Fig. 300). It consists of a hopper, a feeding device, and either one or two distributing wheels. These radial-ribbed distributing wheels are driven by a chain and sprocket, receiving their power from the left rear wheel of the wagon.

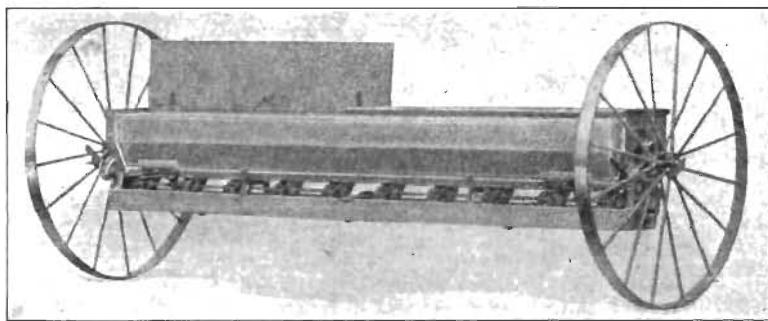


FIG. 301.—Wide-track broadcast seeder.

324. Two-wheel Horse-drawn Broadcaster.—There are two types of two-wheel horse-drawn broadcasters: the narrow track and the wide track (Fig. 301). It is claimed that the narrow-track seeder (Fig. 302) is more practical where covering devices are not used. It also eliminates whipping of the tongue on rough ground.

Both types use the fluted-wheel type of feed. The narrow-track broadcaster has grain spouts hinged to the seed cups and are held in position by a stout coil spring. If a spout should strike a stump or other obstruction, it will swing back out of the way and then return to position.

Markers are provided at each end of the hopper on the narrow-track broadcasters. Markers are not necessary on the wide-track broadcasters,

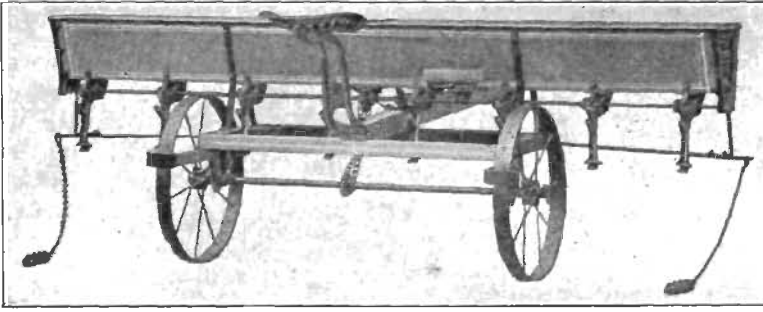


FIG. 302.—Narrow-track broadcast seeder.

because the wheels leave a track which serves as a guide. Where it is desirable to cover the seed, two-wheel wide-track broadcasters can be

TABLE XI.—DUTY OF SEEDING MACHINERY

Location and item	Crew ¹	Rate, acres	Location and item	Crew ¹	Rate, acres
General United States:			Nebraska:		
6-foot drill.....	1—2	9.1	Phelps County:		
8-foot drill.....	1—3	12.2	7-, 8-foot drill.....	1 —3.5	11.4
8-foot drill.....	1—4	14.6	Saline County:		
8-foot drill.....	1—6	16.9	7-, 8-foot drill.....	1 —4.3	11.9
Western New York:			Keith County:		
9-hoe drill.....	1—2	9.6	3—6-, 7-foot drill.....	1 —3.3	10.8
10-hoe drill.....	1—2	10.0	Kansas:		
11-hoe drill.....	1—2	10.4	Pawnee (tractor) 12-, 16-		
Central Illinois:			hoe drill.....	3 —0	35.0
8-foot drill.....	1—4	14.7	Nebraska:		
Utah.....	1—2	11.1	Phelps drill (tractor).....	1 —0	17.8
Kansas:			Keith drill (tractor).....	1.7	36.4
Ford County:			Central Illinois:		
8-, 12-foot drill.....	1—4.8	18.2	End-gate seeder:		
Pawnee County:			20.2 feet.....	1 —2	38.5
8-, 12-foot drill.....	1—4.5	17.4	25.8 feet.....	1 —2	43.3
McPherson County:			30.0 feet.....	1 —2	48.6
8-, 12-foot drill.....	1—4	15.6	34.9 feet.....	1 —2	51.3
Missouri:			39.0 feet.....	1 —2	58.2
Saline County:			General United States:		
7-, 8-foot drill.....	1—3.5	12.5	Knapsack.....		23.0
Jasper County:			Wheelbarrow, 14-foot.....		21.0
6-, 7-, 8-foot drill.....	1—3.2	11.7	Louisiana:		
St. Charles County:			Broadcast by hand:		
8-, 10-foot drill.....	1—3.1	10.5	1½ bushels per acre.....		12.50
			2 bushels per acre.....		14.11

¹ First figure refers to number of men and second figure to number of horses in crew.
U. S. Dept. Agr. Yearbook, 1922.

obtained with hoe-type coverers. Seed boxes are available for mounting on disk harrows and one-way disk plows.

325. Wheelbarrow Broadcaster.—The wheelbarrow seeder is composed of a wheelbarrow frame with a long seed box mounted on the front end. This box is about 3 inches square and about 8 to 16 feet in length.

326. The Duty of Seeding Machinery.—Table XI shows the number of men and the power required to operate the various types of seeders. The table also shows the acreage sown in a 10-hour day for the various types.

PART VI

CULTIVATING MACHINERY

CHAPTER XX

CULTIVATORS

About half of the labor of growing a crop is spent in the preparation of the seed bed and the planting of the seed. When the seed have germinated and the plants are just beginning to get above the top of the soil, it is time to begin stirring the soil around them to prevent and destroy weeds, to keep the top of the soil in such condition as to conserve moisture, and to allow the circulation of air beneath the surface of the soil. All of these are beneficial to the plant, as is seen in the way it thrives.

The main purpose in mind, when cultivating, is to promote the growth of the crop. Otherwise, no cultivation would be needed. The question is, what are the various ways of promoting growth by cultivation? Some are as follows:

1. The leading object is to retain moisture by:
 - a. Killing weeds.
 - b. Loose mulching on surface.
 - c. Retaining rainfall.
2. Develop plant food.
3. Aerate the soil to allow oxygen to penetrate soil.
4. Promote activity of microorganisms.

327. Types.—There are many types of cultivators in use. Some are very crude, using two or three shovels for stirring the soil on one side of the row at a time. Then, there are the very up-to-date types where two, three, or four rows are cultivated at one trip across the field. In order that a brief discussion may be given for all types of cultivators suitable to different conditions, the following classes are given, according to capacity and mode of operation: one-half-row one-horse walking, one-row two-horse walking, one-row two-horse riding, one-row two-horse combination riding and walking, two-row three- or four-horse or tractor riding, and in a few cases three-row horse or tractor riding. When classified according to the equipment and conditions they are designed for, there are shovel, disk, surface, and lister cultivators.

WALKING CULTIVATORS

328. Garden Cultivators.—Figure 303 shows a typical garden cultivator. It is used with either single or double wheels. The cultivating equipment includes a pair of hiller hoes, cultivator teeth, rake teeth, and a plow. Any of the tools used must be operated by hand power.

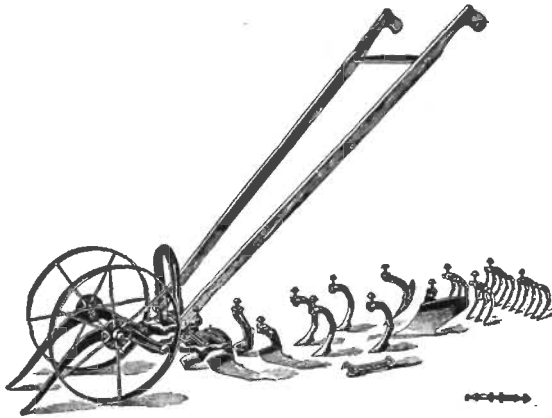


FIG. 303.—Garden cultivator showing various attachments.

329. One-half-row One-horse Walking Cultivator.—Where the farm includes only a few acres and these probably not cleared of stumps, the one-half-row walking cultivator, as shown in Fig. 304, is almost a necessity. Through the timbered belt of the East and South, this type of cultivator is used quite extensively, but it is not advised that it be used

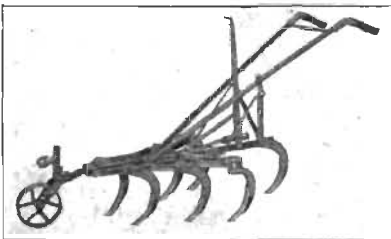


FIG. 304.—Seven-tooth one-horse one-half-row cultivator.

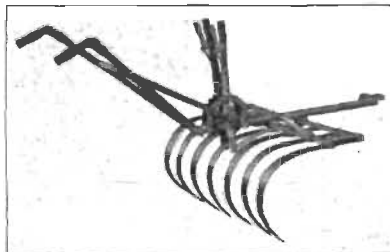


FIG. 305.—Spring-tooth one-horse cultivator.

where any other type can be substituted. To cultivate one row it is necessary to make one trip across the field cultivating half of the middle between the rows and another trip to cultivate the other half.

Using this cultivator to cultivate 40 acres, with the rows 3 feet apart, one, two, three, or four times, a man would travel 219.5, 498.0, 658.5, and 878.0 miles, respectively.

Some of the better types of one-horse one-half-row cultivators have from 5 to 14 shovels placed irregularly on the frame which can be adjusted for width. Figures 305 and 306 show a 5-tooth spring tooth and a 14-tooth cultivator. If the soil is in good condition, there being no large weeds or grass, one complete middle may be cultivated at one trip across the field. If it is not desired to cultivate the complete middle, the shovels

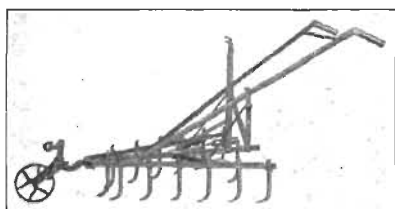


FIG. 306.—Fourteen-tooth scratcher cultivator.

can be drawn closer together by narrowing the frame and one-half row cultivated at one trip across the field.

330. One-row Two-horse Walking Cultivator.—This cultivator, as shown in Fig. 307, will cultivate both sides of the row at one trip across the field.

Two horses are used to pull the machine. This cultivator is mounted upon two wheels, and on a U-shaped axle which is adjustable for width. It, also, has gangs or rigs to which shovels are attached by means of shanks. There may be two or three shovels to the gang. A handle is attached to each gang to enable the operator to control the gangs, shifting them to the side to dodge plants. The parallel shift or cross-head gang shown in Fig. 307 prevents the shovels trailing when shifted sidewise. Each gang is provided with lift-

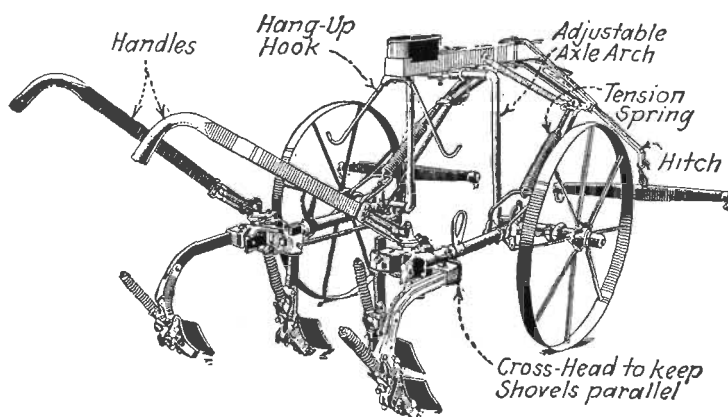


FIG. 307.—One-row walking cultivator.

ing springs to aid in lifting and carrying the greater part of the weight, thereby relieving the operator. When it is not in use, the gangs can be hung up on the hang-up hooks.

On all shovel shanks some provision is made to prevent bending, twisting, and breaking the beam and shank. The methods are the wooden pin, friction trip, and the spring trip shown in Fig. 309.

The walking cultivator is used principally on large plantations of the South where unskilled labor is used. Plantation owners claim that better results can be obtained by having the negro walk than by putting



FIG. 308.—Cultivating young cotton with walking cultivator. (Courtesy Anderson Clayton Company.)

him on a riding cultivator. The reason for this is that he will pay more attention to what he is doing while walking than while riding. If placed on a riding cultivator, he has a tendency to become careless and will not do a good job of cultivating. To avoid any such tendency the plantation

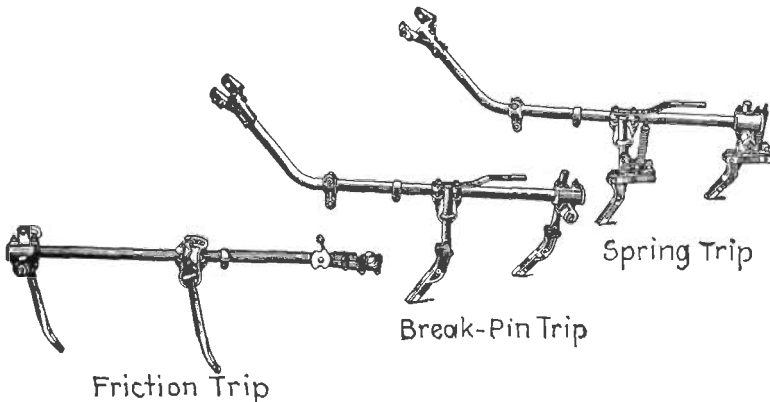


FIG. 309.—Types of cultivator trips.

owners make the operator walk so that he will remain thoroughly awake, giving more attention to the operation of the cultivator and do a better job of cultivation.

To cultivate 40 acres one, two, three, and four times, with a one-row walking cultivator, a man is required to walk 109.7, 219.5, 329.2, and 439.0 miles, respectively

RIDING CULTIVATORS

331. One-row Types.—Generally the one-row riding cultivator is popular in almost all sections where row crops are grown. Of course, there are areas where the two-row or some special type of cultivator predominates. One-row riding cultivators may be classed according to the type of cultivating unit used, which are: shovel, disk, and surface.

332. Shovel Cultivators.—The shovel cultivator with its large variety of shovels, sweeps, and attachments, is the most widely used of all types. A typical one-row riding shovel cultivator is shown in Fig. 310.

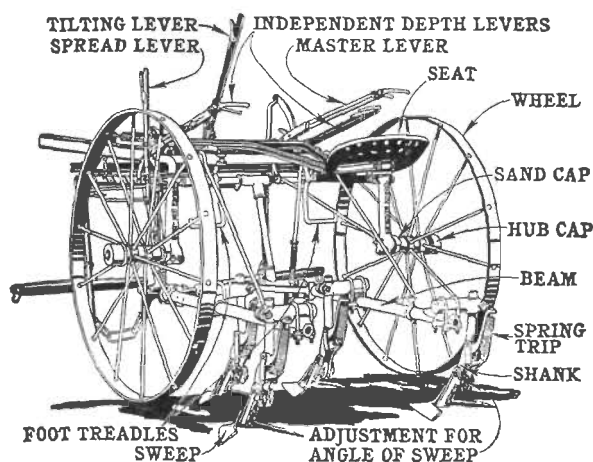


FIG. 310.—One-row riding shovel cultivator.

333. Disk Cultivator.—The disk cultivator, shown in Fig. 311, is not extensively used but finds favor where the plants are grown on ridges or the field is infested with vines. The revolving disks readily cut the vines, thereby preventing their collecting on the gangs. The disk gangs have a wide range of adjustment; they can be set to throw the soil either toward or away from the plants at any desired angle.

Most disk cultivators can be converted into a shovel or spring-tooth cultivator by changing the gangs.

334. Surface Cultivators.—The surface cultivator shown in Fig. 312 is equipped with long blades which do not penetrate deeply. The blades are set at an angle and with sufficient pitch to slice off the weeds and stir the surface of the soil. If deeper penetration is desired, the pitch of the blades is changed to dig in deeper. It is essential that the blades

on both sides be set with the same angle, to prevent the gangs crowding to the right or left.

335. Wheels.—The wheels on riding cultivators are larger than those on walking cultivators and are around 40 inches in diameter. Tires

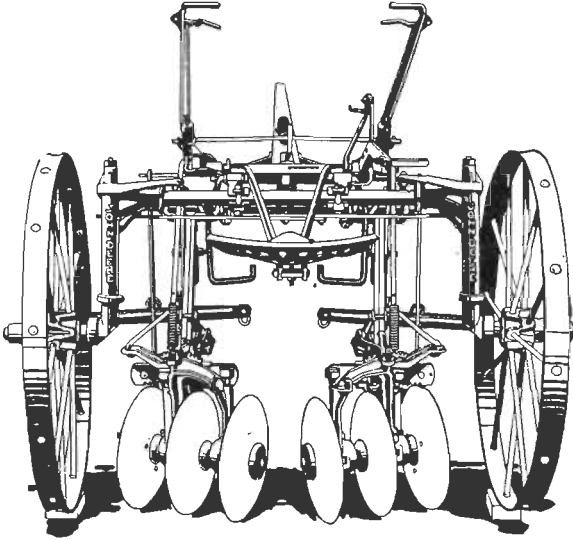


FIG. 311.—Disk cultivator.

may be either concave, flat, oval, or convex. The concave tire is best for sandy land while the flat tire is best for black or heavy lands. The hub of the wheel should have a removable boxing so that, when worn, a

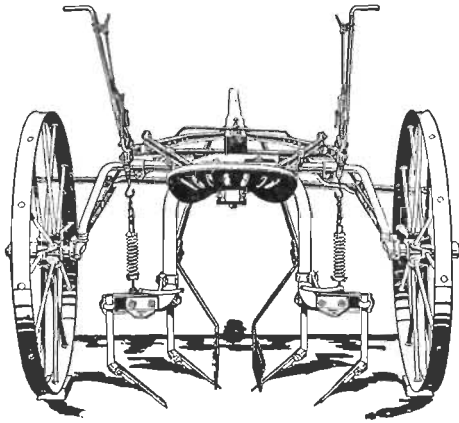


FIG. 312.—Surface cultivator.

new one can be put in and prevent having to buy a complete new wheel.

The wheels are lubricated by means of hub caps, grease cups, and high-pressure fittings.

336. Axles.—Axles on cultivators are never made in one piece. They are always divided in the middle, and the ends of these axles slip into the frame and can be moved in and out to suit the width of the row (Fig. 313).

337. Frame.—The frame forms the real *backbone* of the cultivator. To it are attached the tongue, the levers, the gangs, the seat, and the wheels by means of the axles.

338. Seats.—Two kinds of seats are found on cultivators, namely, the *straddle* (Fig. 310) and the *hammock* (Fig. 322).

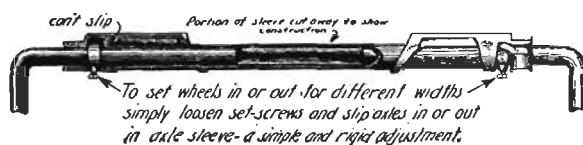


FIG. 313.—Common method of varying distance between cultivator wheels to suit the width between rows.

The straddle seat is the most common. The seat is bolted to a seat bar extending backward from the frame. The operator straddles over the bar in much the same manner as when astride a horse.

The hammock seat is suspended between two bars: thus, the operator has an unobstructed view of the plants.

339. Balancing of Frame.—The cultivator is constructed to automatically balance on the two wheels, both when the shovels are in or out of the ground. When the gangs are raised, however, their weight, which was mostly on the ground, is transferred to the frame back of the axle, thus creating a tendency for the pole to raise in front.

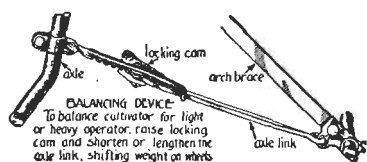


FIG. 314.—Method of shifting position of axle and wheel to balance cultivator frame.

There are two general methods by which cultivators are balanced: First, the entire cultivator frame is shifted forward, with relation to the axle. This means that, as the gangs are raised, the weight of the gangs and of the operator is shifted forward to properly balance the cultivator. Second, the position of the wheels, with relation to the frame, is shifted backward as the gangs are raised. To balance the machine for different weight operators, the wheels can be set backward or forward by means of a series of holes in the lower end of the master lever, or by adjusting the length of the brace rod which extends from the master lever to the axle, as shown in Fig. 314.

LEVERS

Cultivators are equipped with several levers, as shown in Fig. 310, to facilitate their adjustment and handling.

340. Master Lever.—The main function of the master lever is to raise and lower both gangs as a unit. It also aids in shifting the parts necessary to balance the cultivator.

341. Gang Lever.—There is a gang lever for each gang to adjust the depth of the shovels, and raise and lower each gang independently.

342. Spacing Lever.—The spacing lever is used to change the distance between gangs. This may be located conveniently to one side, in front of the operator on the front ends of the gangs, or back of the operator on the rear ends of the gangs. When attached to the gangs in front or rear of operator, it is often called a *jockey arch*.

343. Leveling or Tilting Lever. This lever is located on the rear end of the pole and makes it possible to level the frame and gangs easily and quickly, when using teams of different heights and cultivating up and down hill. It is not necessary to raise and lower the shanks to make the shovels run uniformly in depth.

344. Foot Pedal.—The foot pedals or stirrups may be classed as levers even though they are operated by the feet instead of the hands. They are used to control the gangs, shifting them to either the right or left (Fig. 315).

345. Gangs.—As shown in Figs. 309 and 316, the gang or rig is the complete assembly of beam, shanks, and shovels. There are two to each one-row cultivator. Cultivators may be equipped with four, six, or eight shovels.

346. Beam.—The beam may be made of round, square, flat, I-beam, or channel steel. There are several ways of connecting the beams to the frame.

The type of beam that is becoming most common is shown in Fig. 316. The front end of the beam is curved up and connects directly to the frame. This is usually a rigid connection allowing no lateral movement.

Another method allows the gang to pivot at the front end. The connections are provided with cone couplings which permit taking up lost motion due to wear.

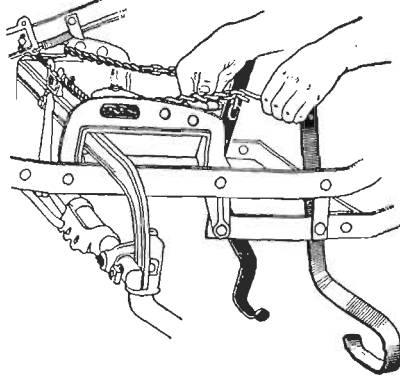


FIG. 315.—Easy method of adjusting foot pedals to suit operator.

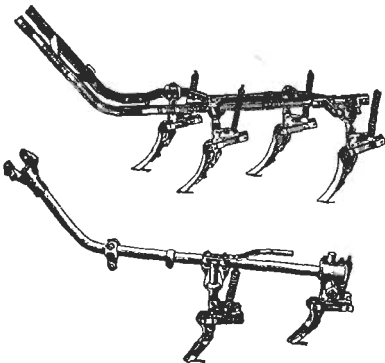


FIG. 316.—Cultivator gangs.

Figure 317 shows how the type of connection will influence the uniformity of penetration of the shovels.

Figure 318 shows how the lateral movement is influenced.

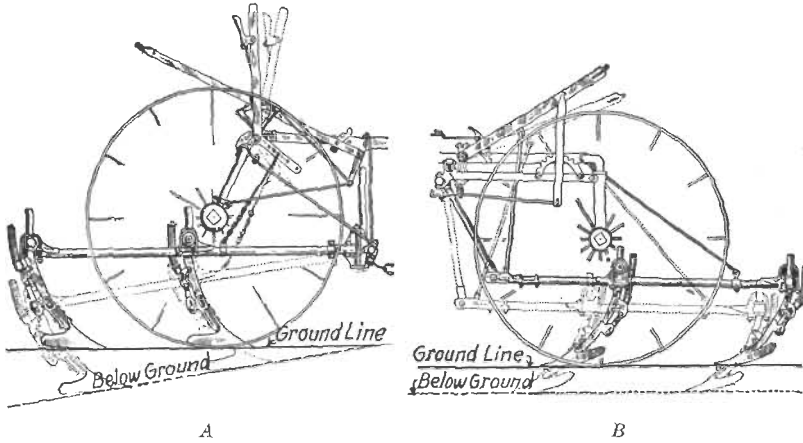


FIG. 317.—A, shows how shovels enter the ground when the gang is hinged at the front and lowered by the lever; B, shows uniform depth of shovels on entering the soil.

347. Shank.—The round or flat pieces fastened, in a vertical position, to the beam by clamps or swiveled eyebolts are called *shanks*.

348. Sleeve.—The lower end of the shank is adjustable and is referred to as the *sleeve*. It may be either round or slotted. Figure 319 shows

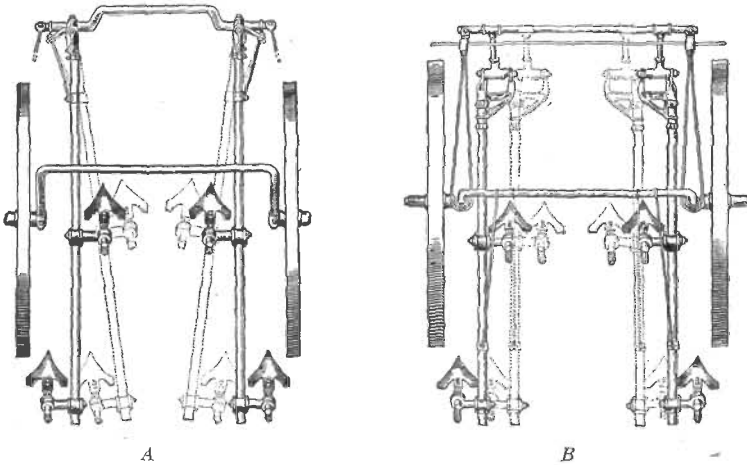


FIG. 318.—A, shows the action and movement of gangs and shovels when pivoted at the front; B, shows the movement when the gangs are shifted parallel.

various settings for cultivator shovels. The setting recommended for shovels is a 47-degree angle. Where sweeps are used, no definite angle can be recommended.

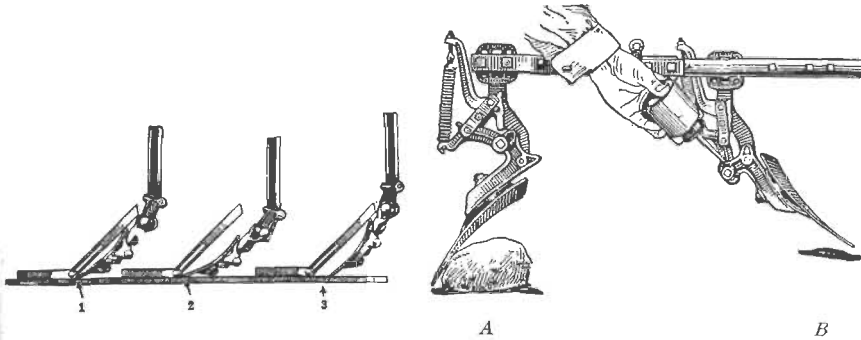


FIG. 319.—Showing correct and incorrect pitch of cultivator shovels: 1, shovel properly adjusted; 2, shovel set too flat; 3, shovel set too straight, will not penetrate or run steadily.

FIG. 320.—Cultivator spring trip: A, trip in action; B, trip should be oiled.

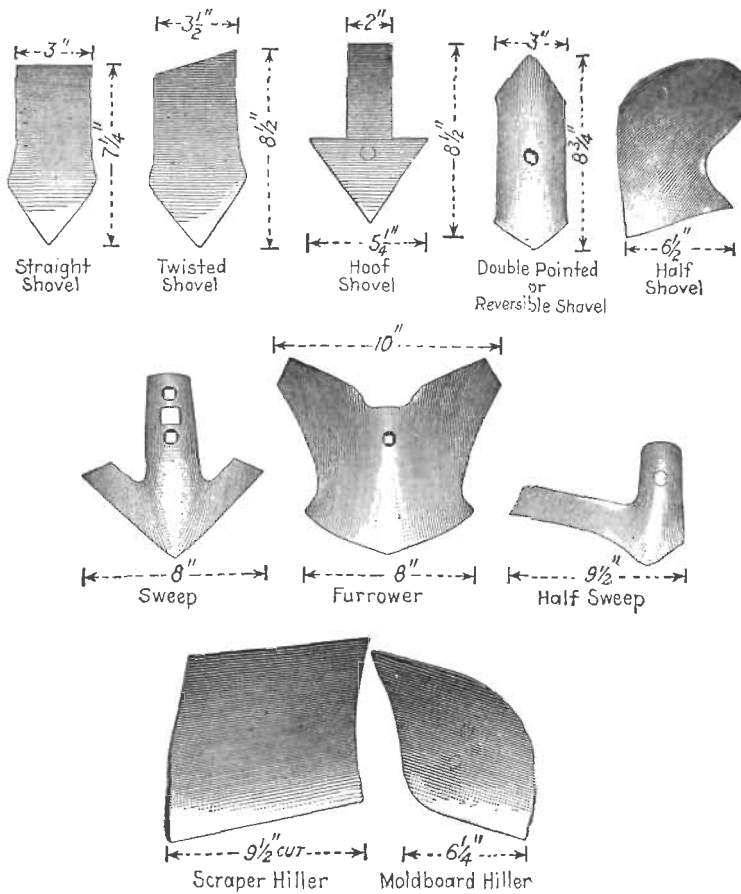


FIG. 321.—Cultivator shovels and sweeps.

349. Trips.—To prevent breaking or twisting the shank when the shovel strikes an obstruction, it is necessary to have a safety device. This is called a *trip*. There are three types, namely, the break pin, the friction, and the spring trip (Fig. 309). The last is most used and is shown in operation in Fig. 320.

350. Shovels and Sweeps.—There are many different types of both shovels and sweeps. Figure 321 shows several types of each. Points for the hoof shovel are now made of knife-section steel.

GANG CONTROL

The most common methods of controlling cultivator gangs, to follow the row and prevent plowing up the plants are: the direct foot control,

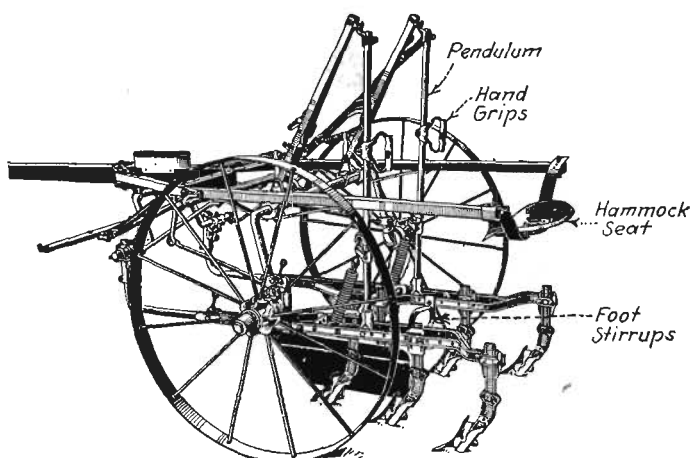


FIG. 322.—Direct foot-controlled type of cultivator.

the seat guide, the pivot axle, the parallel shift, and the combination parallel shift and pivot axle.

351. Direct Foot Control.—To enable the operator to control the gangs by the use of his feet, simply forcing each gang sidewise independently of the other, it is necessary to have the gangs work as freely as possible.

The gangs are fastened to the front arch by pivot couplings and are suspended at the rear by steel pipes or pendulums fastened at the top to rocker arms, which project from the axle arch (Fig. 322). Handles on the pendulums and stirrups on the gangs enable the operator to handle the gangs with his hands, or feet, or both.

352. Seat Guide.—This control is often known as the *wiggletail*, *pivot pole*, or *pivot frame*. The gangs are controlled by shifting the seat sidewise by an easy swaying motion of the body aided by pushing with the feet against the gangs. The seat support, which is fastened to the axle

arch, extends to the rear for the seat and to the front where it pivots with the rear end of the tongue. Therefore, when the rear end of the tongue is moved sideways, to right, or left, by shifting the seat, the frame, wheels, and gangs are angled in the opposite direction.

353. Pivot Axle.—The pivot axle, sometimes called a *pivot wheel* cultivator, gets its name from the way the wheels are pivoted to the right or left. Foot pedals, extending toward the center of the machine, are placed on the axle. Both wheels are so connected that they swing together and remain parallel. A slight pressure on either foot pedal pivots the wheels. No sidewise movement of the gangs is obtained, however, until the cultivator is drawn forward. The whole action is similar to that of steering an automobile.

This control is useful on hillsides, among stumps and trees, and where short turning is practiced.

354. Parallel Shift.—This control is often called the *pivot gang* or *treadle guide*. The gangs are rigidly connected together at the front by bars. Foot levers hanging from the axle arch are connected to the gang bars, usually by chains and pulleys. When it is desired to move the gangs to the right, the operator pushes forward on the right foot lever. This action shifts both gangs to the right as a unit, keeping them equally spaced from front to rear and also parallel.

The tongue, frame, and wheels are held rigid. The gangs are the only parts that shift.

355. Combination Parallel-shift and Pivot Axle.—This type of control is being extensively used, since it gives a quick response and is easily operated. It is, as the name indicates, a combination of the two shifts already described—the parallel shift and the pivot axle.

The front of the gangs is connected to the axle of the wheels. Foot pedals hang from the axle arch and are connected to the front of the gangs by chains and pulleys or rocker arms. The gangs are shifted by pressure on the foot pedals. This shifts the gangs on the frame and simultaneously pivots the wheels. Gangs and wheels move in the same direction, thus, giving a quick response. The gangs remain parallel to the crop row and, consequently, do a thorough job of cultivation (*B* Fig. 318).

356. Hitch.—Two things should be kept in mind in adjusting the hitch on a cultivator. First, hitch the singletree at such a height that it will be on a straight line extending from the shovels in the ground, to the point where the traces are attached to the hames. Second, watch the point where the draft is applied to the gangs. On some cultivators, there is a vertical clevis adjustment at the front of the gangs, so that by hitching higher or lower the gang will run shallower or deeper. The proper adjustment will make considerable difference in the labor of getting the shovels to run at the desired depth.

SPECIAL ATTACHMENTS

A wide range of attachments suitable for different crops can be secured for riding cultivators. They include shields, disk hillers, wing hillers, spring-tooth attachments, fertilizer attachments, tobacco hoeing attachments, center shovel, spring-tooth center shovel, and jockey arch.

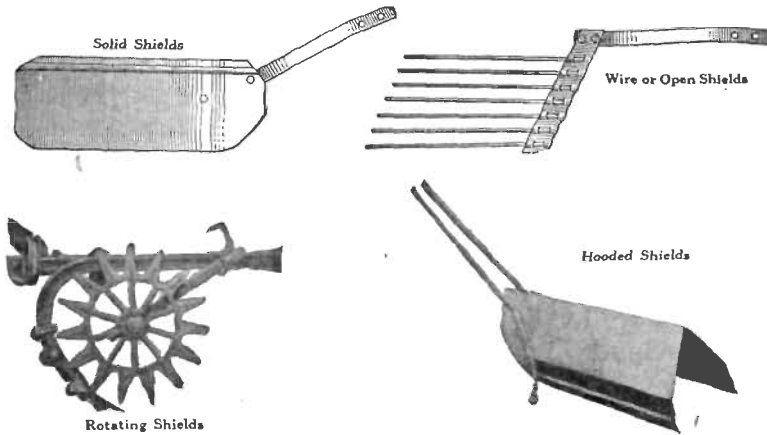


FIG. 323.—Shields or fenders used on cultivators.

357. Shields.—Shields are frequently referred to as *fenders*. There are four types (Fig. 323) namely, the solid, the wire or open, the hooded, and the rotating. The solid and the wire or open types are used quite extensively through the corn belt. The solid is used mostly in the cotton belt. The hooded shield is used where the plants are planted in the listed furrow. Shields are used to prevent young plants from being covered up during early cultivations.

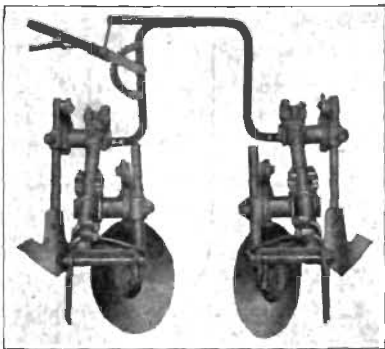


FIG. 324.—Disk-hiller attachment and jockey arch.

358. Disk Hillers.—Figure 324 shows a disk-hiller attachment. It is used to hill crops or for barring-off cotton before chopping.

359. Wing Hillers.—This type of hiller is used for the same purpose as the disk hiller.

360. Spring-tooth Attachment.—Three types of spring-tooth attachments are shown in Fig. 325. Such attachments are used on sandy lands for shallow cultivation to prevent and destroy weeds.

361. Fertilizer Attachment.—Figure 636 shows a fertilizer attachment for a riding cultivator. This makes it possible to apply fertilizer as a *side dressing* while cultivating.

362. Tobacco-hoeing Attachment.—Figure 326 shows an attachment used to cultivate close to tobacco plants.

363. Center Shovel.—Broadcast cultivation is possible when a center shovel is used.

364. Spring-tooth Center Shovel.—An attachment of spring teeth can be placed between the gangs to eradicate weeds.

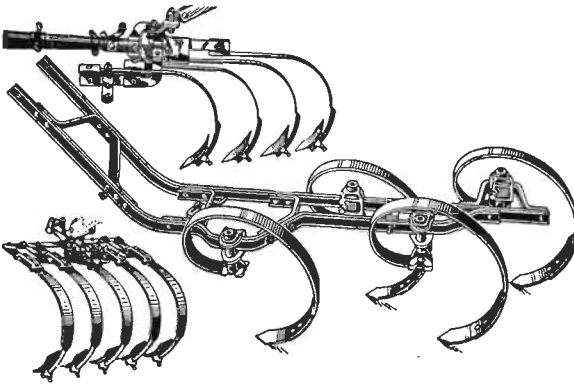


FIG. 325.—Spring-tooth attachments.

365. Jockey Arch.—Figure 324 shows a jockey arch in use on the rear end of the gangs, to space the distance between them.

TWO-ROW CULTIVATORS

For level country and where planting is done with the two-row planter, a large amount of time, labor, and expense is saved by culti-

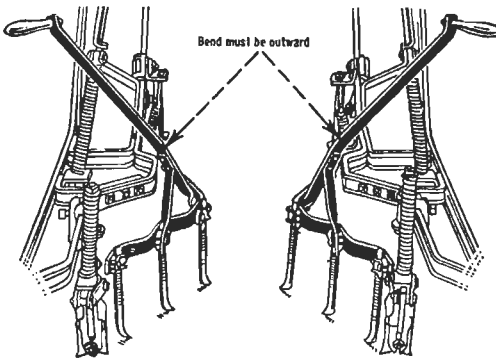


FIG. 326.—Tobacco attachment.

vating with a two-row cultivator. In fact, one-half the time required to cultivate a certain acreage with a one-row outfit is saved by the use of a two-row machine. The average 10-hour day's work with a two-row cultivator is 14.7 acres. The number of horses required to pull the two-row cultivator is three or four.

The principal difference in the construction and handling of the two-row cultivator and the one-row is that the two-row is built much heavier, especially in the frame and wheels. A master lever is provided

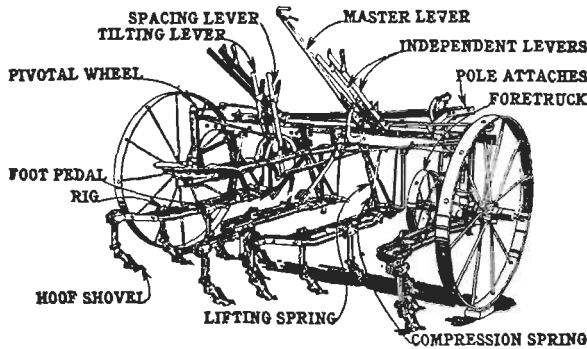


FIG. 327. Two-row shovel cultivator.

to lift all gangs at the same time. Each gang has an independent lever for adjusting the depth. A spacing lever is also provided. These are all shown in Fig. 327.

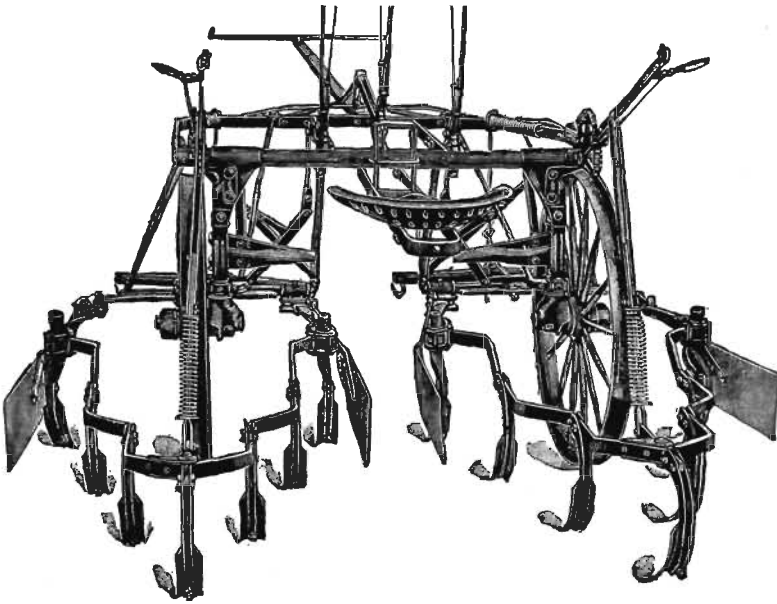


FIG. 328.—Two-row cultivator which straddles one row cultivating two middles.

The distance traveled when cultivating 40 acres with the rows 3 feet apart one, two, three, and four times is 54.9, 109.7, 164.6, and 229.4 miles, respectively. When the rows are 42 inches apart, the distance traveled is 46.2, 92.5, 138.7, and 185.0 miles, respectively.

366. Gang Types for Two-row Cultivators.—There are two general arrangements of the gangs for cultivation on the two-row cultivator; one must have a very wide frame and straddle the two rows which it cultivates, having one gang to cultivate each side of the two rows (Fig. 327). The other has only two gangs placed on a narrow frame and straddles one row, but cultivates two middles (Fig. 328). The first type is the one that requires three to four horses and at the same time requires that the rows be the same distance apart. The second type requires only two horses to cultivate two middles, but it has the disadvantage that cultivation cannot be done close to the plant because there are very

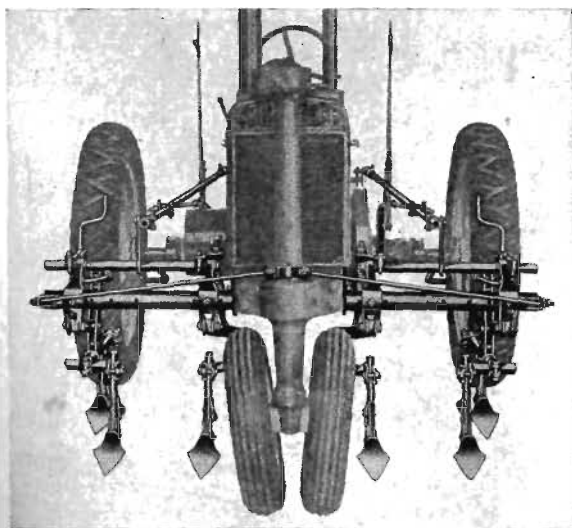


FIG. 329.—Front view of two-row tractor cultivator.

few rows that are the same distance apart, and enough allowance must be made for the narrow rows that will be found. In comparison of the two, the wide frame with the four gangs straddling two rows is the best.

367. Gang Control for the Two-row Cultivators.—There are three methods of controlling gangs on two-row cultivators: the parallel shift, the pivot axle, and a combination of the parallel shift and pivot axle. The last is practically universally used on most two-row machines now. These controls are the same as described under One-row Cultivators.

368. Forecarriage.—The large two-row cultivators have a special forecarriage or tongue truck to carry the weight of the front of the frame (Fig. 327).

369. Tractor Cultivators.—Tractor cultivators similar to those shown in Figs. 329 to 331 are extensively used for cultivating row crops, especially corn, cotton, and sorghum. All crops cultivated with two-



FIG. 330.—Tractor cultivator cultivating four rows of corn. Note all the gangs are hinged to a pipe extending across the front of the tractor.



FIG. 331.—Tractor cultivator cultivating four rows of cotton. Note that part of the gangs are in front and part in the rear of the operator.

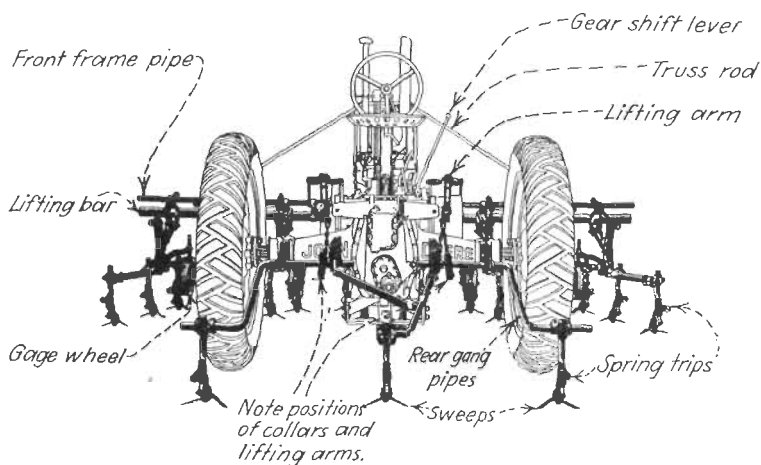


FIG. 332.—Rear view of four-row tractor cultivator.

and four-row tractor cultivators should be planted with two- and four-row planters.

The gangs may all be mounted toward the front of the tractor or they may be divided and part of them located to the front and part to the rear of the operator. The cultivator forms a single unit with the tractor and is controlled entirely from the tractor seat. As the tractor is steered to the right or left, the front gangs are automatically shifted in the direction the tractor is steered. Some machines are provided with a gang shift in addition to the steering shift. As a rule, the rear gangs are rigidly mounted and cannot be shifted. Many tractor-cultivator units have levers to adjust the depth of the shovels, but most of them are provided with power lifts to raise the gangs while turning. On the larger units each gang is equipped with individual gage wheels, so that the shovels follow the contour of the ground along the row.

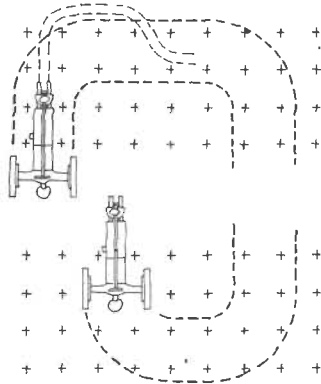


FIG. 333. Method of turning two-row tractor when cultivating corn planted with check-row planter. Two or more rows are passed at the ends.

All the accessories mentioned in connection with horse-drawn cultivators have been adapted for tractor cultivators and can be obtained as special equipment.

A six-row outfit is made by trailing two two-row riding cultivators on the sides and rear of the regular two-row tractor cultivator.

TABLE XII.—ACCOMPLISHMENTS OF ANIMAL AND TRACTOR POWER IN CULTIVATING COTTON, CORPUS CHRISTI AREA¹

Horse	Tractor	Size of implement	Crew			Hours per acre			Horse equivalent of tractor	Acres covered 10-hour day
			Man	Horse	Tractor	Man	Horse	Tractor		
Horse	.....	Two-row	1	4	..	0.65	2.60	....	.....	15.4 ¹
	Tractor	Two-row	1*	..	1	0.45	....	0.42	6.20	23.8
	Tractor	Four-row	2†	..	1	0.50	....	0.23	11.30	43.5
	Tractor	Six-row	3*	..	1	0.58	....	0.19	13.70	52.6

¹ Tex. Agr. Expt. Sta. Bull. 362, p. 13, 1927.

* Additional labor used on some farms.

† Number of men in crew varies from one to three, with an average of approximately two men to the crew. There is a strong tendency for the four-row one-man tractor outfit to become standard.

370. Comparison of Horse and Tractor Cultivators.—An interesting fact shown in Table XII is the horse equivalent of the tractor, for the different size cultivators. The number of horses displaced by the tractor or the number which would be required to do the same amount of work as one tractor in an equal period of time ranged from 6.2 for the two-row,

11.3 for the four-row, to 13.7 for the six-row cultivator, when compared with the usual two-row horse-drawn cultivator.

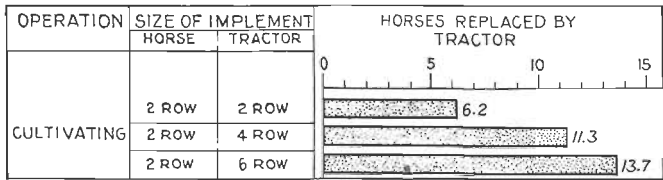


FIG. 334.—Showing graphically the number of horses replaced by tractors, when cultivating 2, 4, and 6 rows of cotton.

Comparison for cultivating shows 15.4 acres for a two-row horse outfit and 23.8 acres for a two-row tractor outfit. Four- and six-row tractor-drawn outfits cultivated, on an average, 43.5 and 52.6 acres, respectively, during a 10-hour day.

The horse equivalent of cultivators is shown graphically in Fig. 334. The greater acreage covered by the tractor pulling an implement of the same size as that drawn by horses is for the most part due to:

- 1. Its greater speed.
- 2. The relative small amount of time lost in turning at the ends.
- 3. No stop for rest.

LISTER CULTIVATORS

Lister cultivators are particularly adapted to the cultivation of a listed crop in its early stages of development. Listed crops are those planted in the listed furrow or trench, or below the general level of the ground. There are four general types of lister cultivators; sled, wheel, two-row, and three-row.

371. Sled Lister Cultivator.—The sled cultivator is known in some localities as the *go-devil*. Figure 335 shows the complete outfit. It consists of

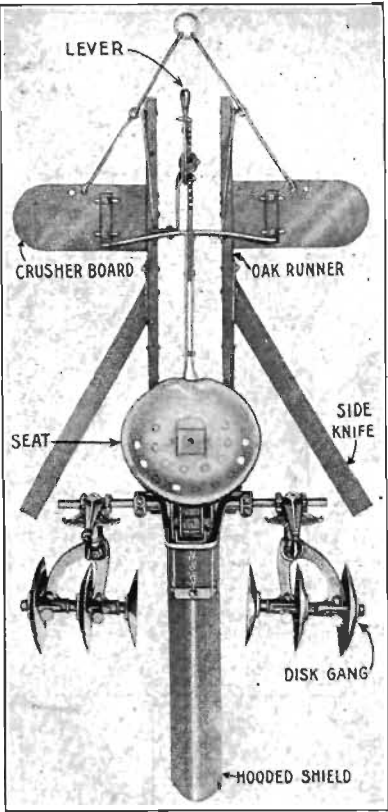


FIG. 335.—Sled lister cultivator.

two oak runners to which are attached crusher boards near the front end. Just back of these, on each side, are attached large side knives, to destroy weeds and level the middles. Gangs of disks are

coupled to the rear arch. They can be raised and lowered and moved in and out. Each gang is composed of three steel disks, 10, 11, and 12 inches in diameter. They have wood bearings.

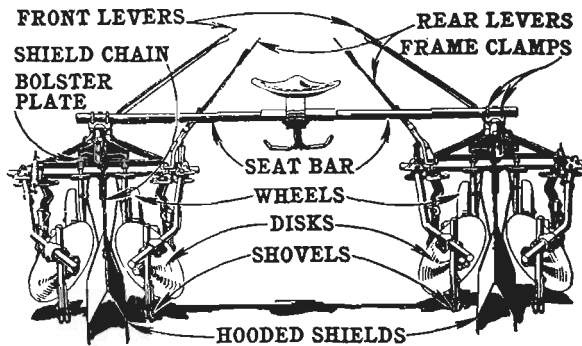


FIG. 336.—Two-row lister cultivator set for first cultivation.

372. Wheeled Lister Cultivators.—The essential difference between the sled lister and the wheeled lister cultivator is that balance wheels are used instead of runners. Friction is reduced which greatly lessens the draft. It is also built higher, placing the driver far enough above the ground to avoid the dust and in a better position to handle his team.

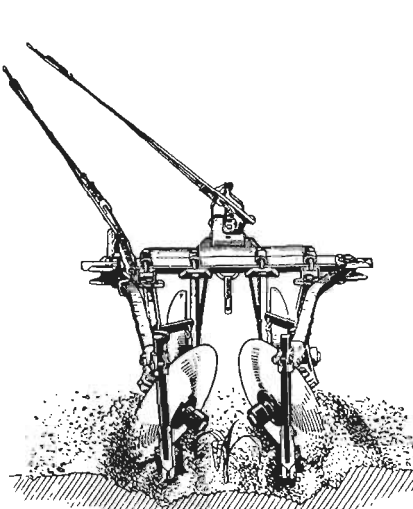


FIG. 337.—First operation—regular cultivation.

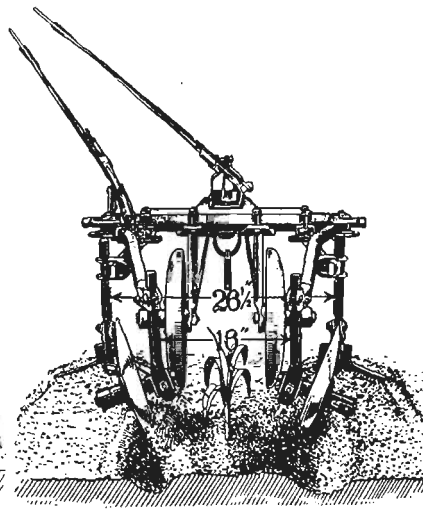


FIG. 338.—Second operation with attachment.

The main lever raises disks, shovels, and shield as a unit. The secondary lever raises shovels and shield only. A compression spring gives necessary flexibility in crossing gullies or other depressions. Lister

cultivators can be obtained in two-, three-, four-, and five-row combinations.

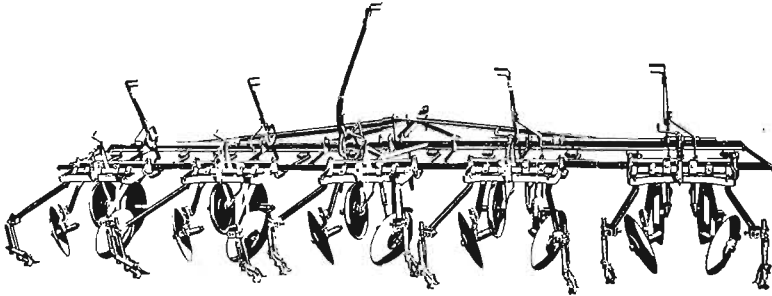


FIG. 339.—Five-row tractor-drawn lister cultivator.

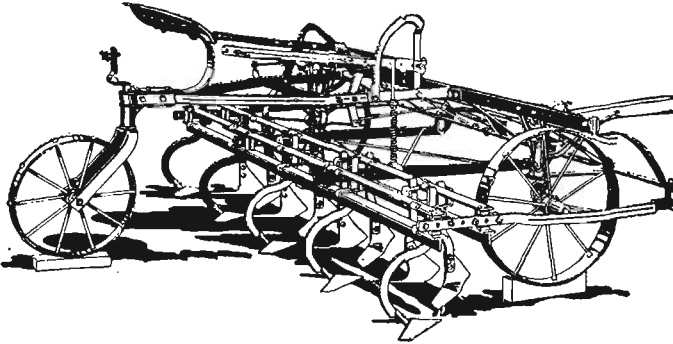


FIG. 340.—Beet and bean cultivator.

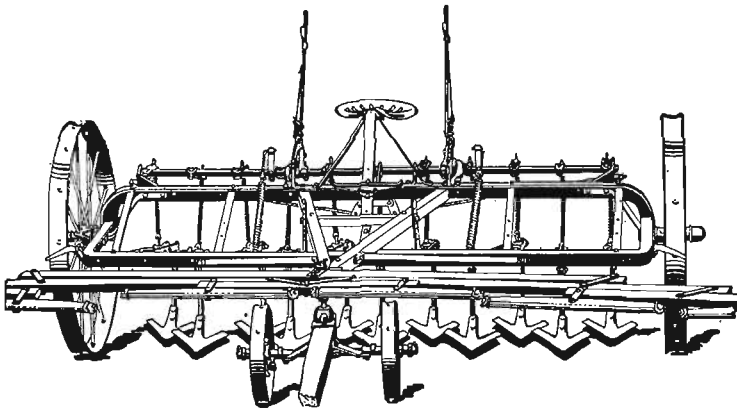


FIG. 341.—Field cultivator.

The two-row horse-drawn lister cultivator, shown in Fig. 336, consists of two units of the wheeled type connected together by seat bar. Each unit will follow its row whether the rows are parallel or not. For it to accomplish this, however, the disks and shovels on each side of the

row must be set at exactly the same angle as on the other side. The cross-row forces are then equalized, allowing the machine to run straight forward.

For the first cultivation, the disks are set to throw the soil away from the plants, as shown in Fig. 337. The shovels are set to stir the edge of

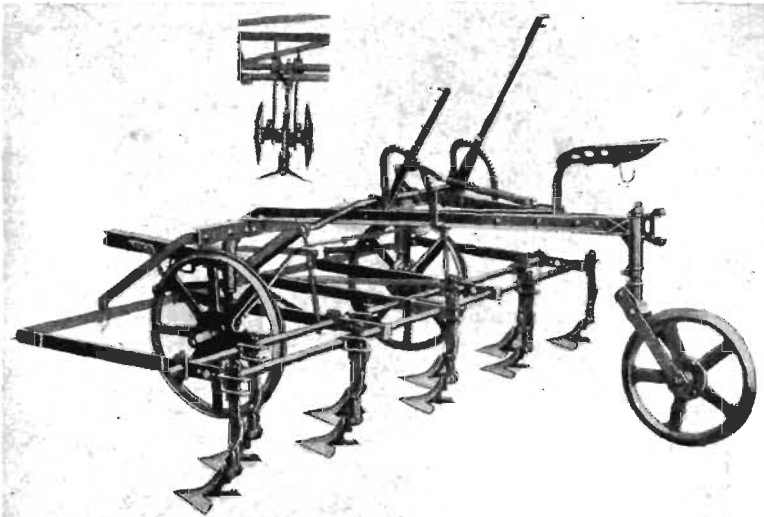


FIG. 342.—Cross-row cotton chopper. The inset shows disks for cutting vines and grass and for blocking out the plants.

the trench. The hood shield prevents the young plants from being covered.

When cultivating the second time, the disks are set to throw the soil into the trench around the growing crop (Fig. 338). The shovels are set wide to cultivate between the rows. If desired, sweeps and knives can be substituted for the disks and shovels.

Tractor lister cultivators can be obtained in units ranging from two- to five-rows. Figure 339 shows a five-row lister cultivator.

373. Beet and Bean Cultivators.

Figure 340 shows a four-row cultivator especially designed for cultivation of crops grown in narrow rows. Two-row and three-row machines can also be secured. This type of cultivator with some slight changes is being tried out in the cotton belt to thin and block cotton, in the hope

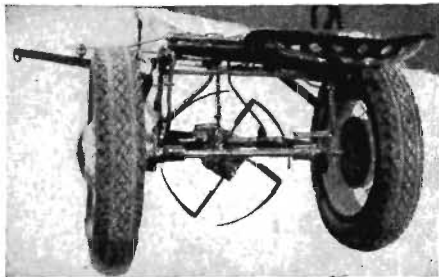


FIG. 343.—Cotton chopper equipped with rotary knives.

that the slow, laborious, and costly job of chopping cotton with the hand hoe may be eliminated.

374. Field Cultivators.—A typical field cultivator is shown in Fig. 341. It is used for summer fallowing and to eradicate various kinds of weeds in large fields.



FIG. 344.—Chopping cotton by hand. (Courtesy Anderson Clayton Company.)

375. Draft of Cultivators.—Very little research has been done to determine the draft of a cultivator. The "Extension Service Handbook"¹ gives, for a corn cultivator, 130 to 300 pounds draft per row covered. The horsepower hours per acre vary from 1 to 2.5.

376. Cotton Choppers.—The cotton grower is greatly interested in a mechanical device for thinning his cotton. Figures 342 and 343

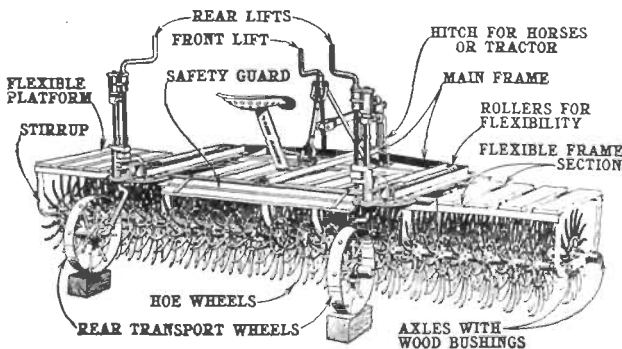


FIG. 345.—Three-row horse-drawn rotary hoe.

show attempts to construct such a tool. The greatest objection to the machines available is that they will only block the cotton. That is, the cotton is left with several plants per hill some 8 or 10 inches between hills. The prevailing practice is to thin to a single stalk stand. Another

¹"Extension Service Handbook on Agriculture and Home Economics," U. S. Dept. Agr., 1926.

objection is that if the plants are not properly spaced, the machine will likely cut out the plants that it is desired to leave. There is a tendency

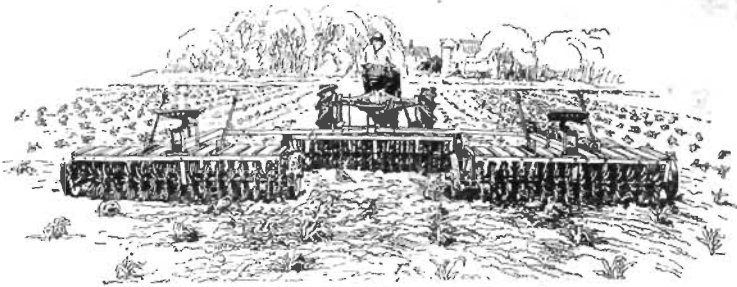


FIG. 346.—Tractor pulling three rotary hoes.



FIG. 347.—Rod weeder.

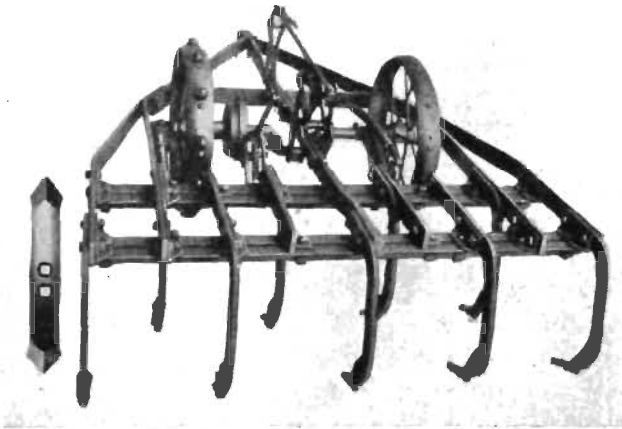


FIG. 348.—Nine-standard subsoil cultivator equipped with double-pointed shovels.

in certain sections of the South, however, to leave more than one plant per hill. In some instances, they plant thin and do not attempt to chop

at all. The elimination of hand chopping (Fig. 344), if it can be done without materially affecting the yield, will reduce the cost of production.

377. Rotary Hoe.—The machine shown in Fig. 345 is called a *rotary* hoe because it is designed to break up the soil crust, stir the soil close to the young plants, allow air and light to warm up the soil, and to



FIG. 349.—Five-standard subsoil cultivator.

destroy young weeds just starting to take root. It can be used to advantage in young corn, soybeans, cotton, potatoes, wheat, and oats.

378. Rod Weeders.—The rod weeder (Fig. 347) is a machine for the cultivation of summer fallow land. The weeds are pulled up by a slowly rotating round or square rod about $\frac{1}{2}$ inch in diameter and supported by several subsoil points. The rod is drawn a few inches under the surface of the soil and catches the weeds and pulls them out. The revolving rod prevents the weeds from collecting on

it. Sizes of rod weeders range from 9 to 18 feet.

379. Subsoil Cultivators.—Subsoil cultivators (Fig. 348) are also called *subsoil tillers*, *chisel plows*, and *orchard cultivators*. These cultivators stir the subsoil without raising it to the surface. Breaking up the subsoil, hardpan, and plow sole aids root penetration, permits deeper circulation of air, and increases the water absorption and holding capacity of the soil. This type of tool is used in irrigated sections to break up hardpans. Power lifts are provided to raise and lower the shovels.

Attachments are available for converting the subsoil cultivator into a lister, a regular subsoiler, and a border ridger.

PART VII

DUSTING AND SPRAYING MACHINERY

CHAPTER XXI

DUSTING AND SPRAYING EQUIPMENT

The problem of controlling insect pests and plant diseases makes it necessary for a large percentage of farmers and orchardists to include in their farm equipment machines for applying either dust or liquid insecticides and fungicides. It is estimated that insect pests and plant diseases cause an annual loss of several million dollars.¹ In addition to these losses there is the cost of purchasing spraying equipment and material, maintenance of equipment, and application of sprays and dusts.

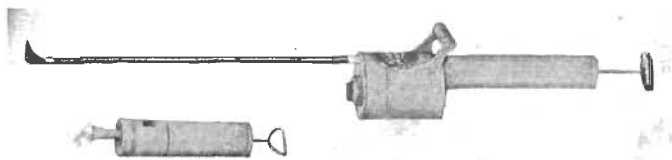


FIG. 350.—Hand dusters.

The selection of the proper equipment to combat a certain insect pest or plant disease is a problem that needs careful consideration.

DUST SPRAYERS

Many insects and plant diseases can be controlled more effectively and economically with dusts than with liquid sprays. Thousands of acres of cotton are annually dusted with calcium arsenate to control the boll weevil and leaf worm. Potatoes and other field crops, as well as garden and orchard crops, are dusted with various kinds of insecticides and fungicides. Dusts may be applied with hand dusters, traction dusters, power take-off dusters, and airplanes.

380. Hand Dusters.—The small hand-pump dusters shown in Fig. 350 are useful where only a few vegetables or flowers are to be dusted. The special nozzle on the extension tube is for dusting upward from beneath plants and vines. The crank duster (Fig. 351) is used where small areas of plants are dusted. The duster is provided with both single and

¹ *Agr. Eng.*, Vol. 17, No. 1, p. 13, 1936.

double nozzles. The fan for blowing the dust is driven by a chain, and speed is obtained by gears. A saddle duster is shown in Fig. 352. The

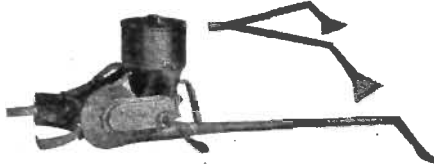


FIG. 351.—Hand-gun duster.

outfit is placed on a mule or horse so that the operator may ride and dust a row on each side.

381. Horse-drawn Ground-driven Dusters.—A small one-mule



FIG. 352.—Saddle-gun duster.

two-row duster is shown in Fig. 353. The machine is drawn by one mule and dusts two rows of cotton. The nozzles extend back behind the operator, who walks and guides the machine, turning it at the ends. The large wheel furnishes power for driving the agitators and fan.

Figure 354 shows a one-horse, two-wheel, three-row traction duster. The large wheel drives the feed and the fan and supports most of the weight of the machine. The small wheel acts as a platform wheel similar to that on a binder.

The traction power-cart duster (Fig. 355) is mounted on two wheels, one or both of which may furnish power for operating the dusting mechanism. In most machines the axle is adjustable for differ-

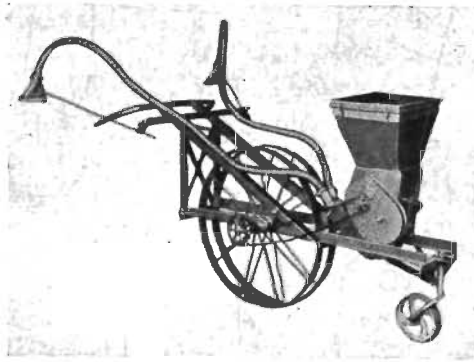


FIG. 353.—One-mule two-row traction duster.

ent width rows and is arched to a height sufficient to clear the plants.

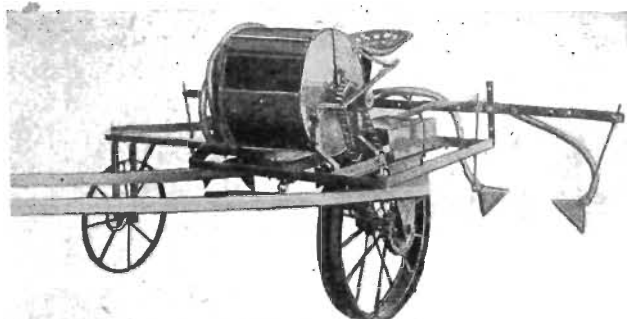


FIG. 354.—Front view of three-row one-horse outrigger duster.

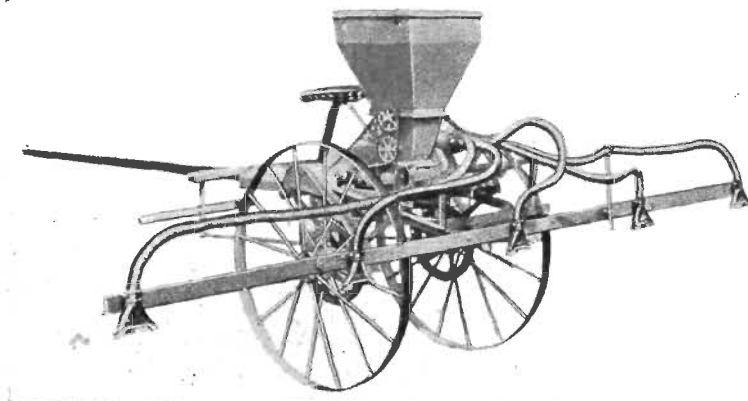


FIG. 355.—Two-wheel traction duster.



FIG. 356.—Rear view of power-cart duster dusting young cotton.

Straight axles are used on machines for dusting potatoes and other low-growing crops. For cotton only one nozzle is required for each row dusted, but for some crops two nozzles are required.

382. Power-cart Duster.—This machine has a gasoline engine mounted on the platform to furnish power to operate the dusting mecha-

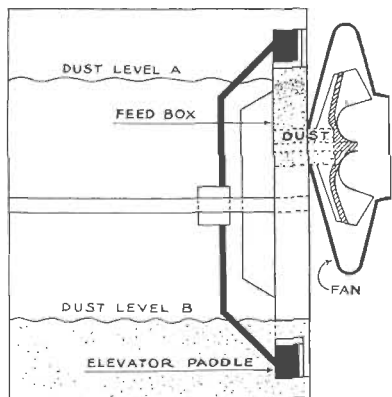


FIG. 357.—Cross-section of elevating feed for duster.

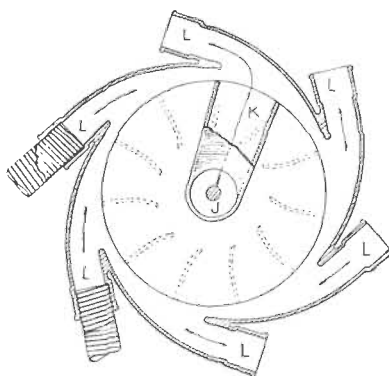


FIG. 358.—A sectional view of centrifugal discharge fan and fan housing.

nism. The engine furnishes power to produce a sufficient velocity of air to break up and separate the dust particles into a fine fog-like mist, which is distributed uniformly over the plants. Other features of the power-cart duster are practically the same as for the traction-power-cart duster. Enough nozzles can be installed to dust up to ten rows of plants.



FIG. 359.—Tractor-mounted cotton duster.

Power-dusting units consisting of a complete dusting machine and engine mounted upon a suitable base ready for operation are available. These units can be mounted upon any homemade cart or truck.

383. Tractor-power Field Dusters.—Figure 359 shows a dusting unit mounted upon a platform bolted to the rear of a tractor and operated

by the power take-off. Operating the tractor in high gear makes it possible to dust a larger acreage than with horse-drawn machinery of equal row capacity.

384. Orchard Power Dusters.—Figure 360 shows an orchard duster equipped with an auxiliary engine. Others may be mounted on the rear of a tractor and driven from the power take-off. Power units can be mounted on the floor of a truck, thus saving the cost of a special sprayer chassis. Orchard dusters have only one large flexible metal hose, which can be turned to direct dust in any direction.

385. Agitators.—Agitators are to prevent dust preparations from caking and packing in the hopper. Most agitators consist of projections from horizontally mounted shafts, which revolve and keep the dust broken up.



FIG. 360.—Power fruit duster.

386. Feeds.—Best results are obtained from dust “poisons” when they are broken up into a fine fog-like dust. If small pellet-like particles are blown out, they do not adhere to the plants as well as a very fine dust. The feed usually consists of an opening into the air stream or fan housing. Revolving over the opening is a brush or curved blades, to which leather strips may or may not be attached. The dust is uniformly fed either directly into the fan or into the air stream coming from the fan. The high velocity of the air aids in breaking the dust into a fine fog.

387. Fan.—The centrifugal type of fan is most often used on dusting machines. Fans usually have only one discharge opening, as shown in Figs. 358 and 361. However, the fan shown in Fig. 358 has an opening for each hose. Fans operate from 2,500 to 5,000 r.p.m. One company claims their power machine will produce an air velocity of 125 miles per hour at the fan outlet.

388. Airplane Dusters.—Airplanes have been successfully used to apply dust to both field crops and orchards. A V-shaped hopper capable of holding 500 pounds of calcium arsenate is built inside the fuselage

in the space ordinarily occupied by the front seat. The opening in the top for filling is covered by a close fitting lid, hinged in front. The dust in the hopper is stirred just above the outlet at the bottom by an agitator driven by a small propeller mounted on the lower wing (Fig. 363). The feed consists of an opening across the width of the fuselage. A slide covering the opening is operated by the pilot. The amount the feed valve is opened regulates the flow of dust and determines the poundage applied per acre. A venturi nozzle (Fig. 363) is mounted underneath the fuselage and slightly in front of the dust outlet. The rear end of the nozzle is tipped slightly downward. The blast of air, which is created

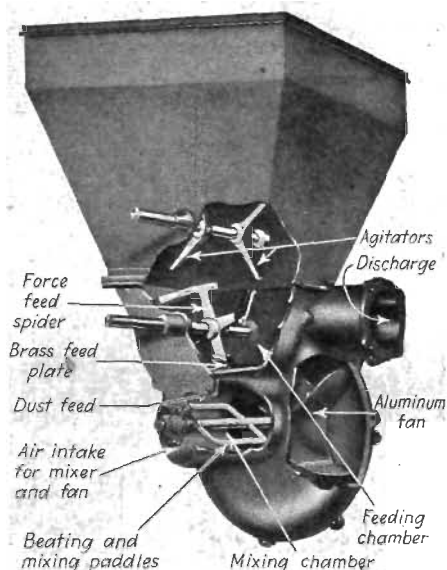


FIG. 361.—Sectional view of a duster showing hopper, agitators, feed, and fan.

by the plane's propeller, rushes through the venturi nozzle at a high velocity, catching the dust and discharging it in a whirling cylindrical column that spreads and settles on the plants. It is claimed that the high velocity of air through the nozzle creates a partial vacuum in the feed opening, and this aids the flow of dust.

An airplane can dust approximately 350 or more acres per hour, which is many times the acreage that can be dusted with any other type of machine in the same length of time.¹ Data kept on the time required for airplane operations show the average loading time to be 3 minutes 5 seconds, average flying time per load 14 minutes 30 seconds, and the average dusting time per load 4 minutes 45 seconds. About one-third of the time is spent in actually dusting, the remainder being consumed in

¹ U. S. Dept. Agr. Farmers' Bull. 1729, p. 14, 1934.

turning and flying to and from the landing field.¹ The average contract price in 1936 for applying poisons to cotton was 4.5 cents per pound. The farmer furnished and paid for the poison.



FIG. 362.—Dusting cotton by airplane. (*U. S. Department of Agriculture.*)

LIQUID SPRAYERS

Several liquid sprays are: Bordeaux mixture, lime-sulphur solution, fish-oil soaps, oils, and oil emulsions. Machines for applying liquid sprays differ from dusting machines because the sprayer requires a pump instead of a fan to force the liquid out through the nozzle, which can be adjusted to regulate the quantity applied. Power sprayers

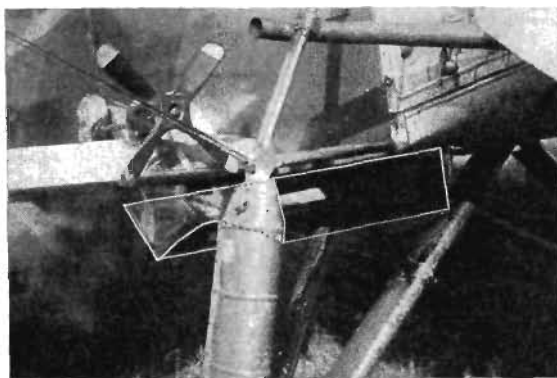


FIG. 363.—Agitator drive and venturi nozzle of airplane duster.

require a pressure regulator to take care of the pressure created by the pump when all the nozzles are closed.

389. Hand Sprayer or Atomizer.—The hand sprayer or atomizer is invaluable for spraying all kinds of solutions around the home, in the garden, poultry house, and barns. There are two types; namely, the single-action and continuous-action atomizer. The single-action type only acts on the stroke of the pump, but the continuous atomizer builds

¹ *Tex. Agr. Expt. Sta. Bull.* 394, p. 32, 1929

up enough pressure after two or three strokes of the pump to force out a continuous stream of spray (Fig. 364). The liquid containers are made of tin, glass, brass, and copper-bearing sheet steel. The last is adapted for spraying oils, chemicals of heavy consistency, floor oils, and fly repellents.

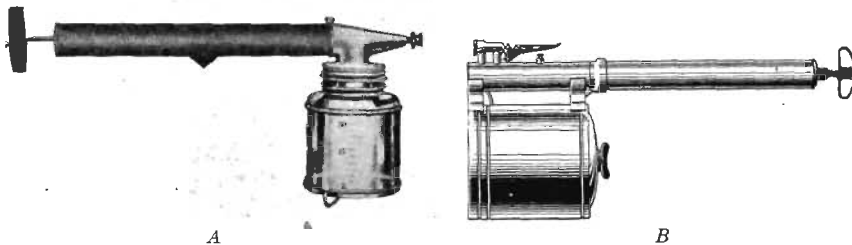


FIG. 364.—A, continuous-action hand atomizer; B, continuous-action hand atomizer designed to spray oils, chemical solutions, and fly repellents.

390. Bucket Sprayers.—The bucket sprayer (Fig. 365) is designed so that the pump sets inside a bucket, and a footrest sets on the ground outside. The footrest holds and steadies the pump, which pumps only on the down stroke. A strong continuous flow of liquid is forced through the nozzle under pressure of 50 to 100 pounds.

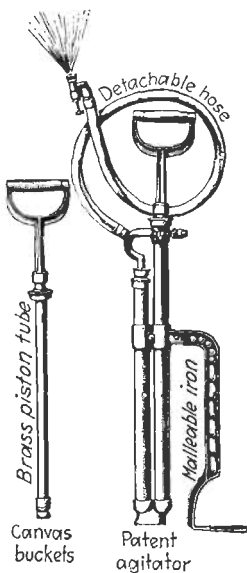


FIG. 365.—Double-acting bucket spray pump.

391. Barrel Sprayers.—This sprayer consists of a double-acting hand pump connected to a barrel or tank, which may or may not be mounted on a wheelbarrow-like frame. Some type of jet or dash agitator is provided to keep the spray solution stirred up. Strainers prevent small particles of sediment from getting into the hose line or nozzle (Fig. 366).

392. Knapsack Sprayers.—A 4-gallon capacity kidney-shaped tank made of galvanized steel or sheet brass is carried on the back and shoulders of the operator. A lever handle located at the bottom of the tank makes operation of the pump easy (Fig. 367). A few strokes of the pump builds up pressure in the air chamber so that when the nozzle is opened a strong flow of liquid spray is assured. Knapsack tanks can be equipped with a double-acting, continuous-spraying, high-pressure, fire-fighting pump (Fig. 368) that will generate a pressure of 200 pounds and throw a stream of water 60 to 70 feet.

393. Compressed-air Sprayers.—This type of sprayer consists of a cylindrical tank equipped with an air pump (Fig. 369). The tank capacity ranges from $2\frac{1}{2}$ to 4 gallons. When filled, the tank has enough space left so that a good volume of air can be compressed above the liquid and expanded sufficiently to force the spray out. The pump



FIG. 366.—Barrel sprayer.

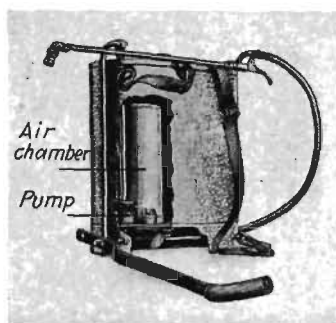


FIG. 367.—Knapsack sprayer with cutaway section to show pump and air chamber.

handle locks down and serves as a wrench for tightening and unscrewing the pump and for carrying the tank. Good spraying is obtained with 50 to 80 strokes of the pump. The author has used a high-pressure sprayer of this type made of heavy steel to stand a working air pressure of 120 pounds (Fig. 370). This sprayer was used to spray a highly atomized mist of arsenical poisons on prickly pear (cactus).

394. Power Sprayers.—Power sprayers are shown in Figs. 371 and 372. They usually consist of a tank, pump, engine, pressure regulator, hose or pipes, and nozzles. Power sprayers are designed for spraying row crops (Fig. 371), fruit trees (Fig. 372), and broadcast crops.

Tanks are constructed of wood or sheet metal that will not corrode. The capacity ranges from 100 to 400 gallons.

The *pump* usually has two or three plungers and is styled duplex or triplex. They must be constructed to stand in some instances pressures up to 650 pounds per square inch and capable of discharging from 5 to 40 gallons per minute.

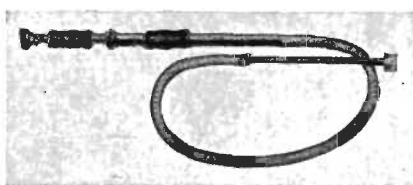


FIG. 368.—Trombone double-acting high-pressure spray pump.

Pressure regulators are provided to take care of the pressure created by the pump when the nozzles are closed. A by-pass valve is automatically

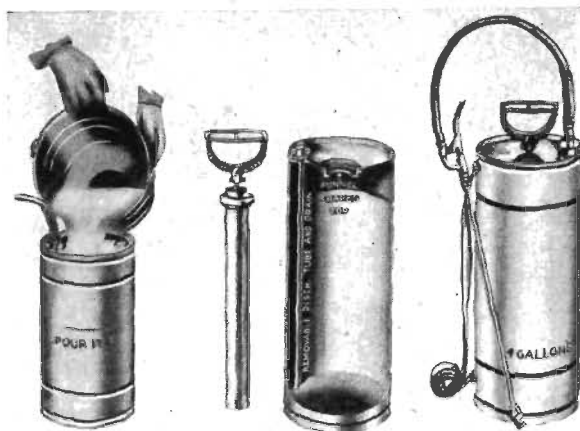


FIG. 369.—Compressed-air sprayer with depressed top, which serves as a funnel when filling the tank.

opened permitting the liquid to be returned direct to the tank until the nozzles are opened again (Fig. 373).

395. Stationary Spray Plants.—A stationary spray plant is an outfit that remains in a fixed place. In general, the plant consists of a large-capacity tank, a power unit and pump of sufficient capacity to force spray liquids through underground pipes to all parts of the orchard. Lacy¹ enumerates fourteen advantages and only three disadvantages for stationary spray plants.

396. Nozzles.—When classed according to construction, there are five principal types of nozzles known as (1) disk (Fig. 375), (2) regular vermorel (Fig. 374), (3) modified vermorel (Fig. 374), (4) the self-cleaner (Fig. 375), and (5) Bordeaux (Fig. 375). Different nozzles are suited to different work, and the pressure used affects their efficiency. The disk and Bordeaux nozzles have a larger capacity than the vermorel and self-cleaner types.² The type of spray, whether fine or coarse, can be regulated to some extent by size, number, and angle of the holes in the disk. The Bordeaux nozzle usually makes a flat, fan-shaped spray, which may be rather coarse and much heavier in the center than at the



FIG. 370.—Australian prickly-pear atomizer.

edges. High pressure and small orifices help in making a highly atomized

¹ *Agr. Eng.*, Vol. 13, No. 1, p. 19, 1932.

² *Ohio Agr. Expt. Sta. Bull.* 248, p. 791, 1912.



FIG. 371.—Horse-drawn power sprayer spraying potatoes.



FIG. 372.—Orchard sprayer operated by power take-off of tractor.

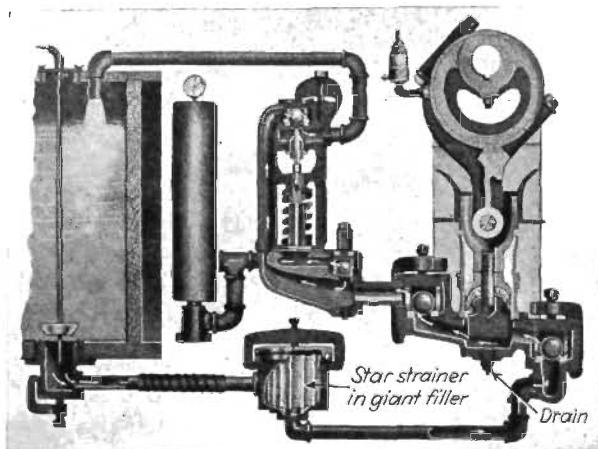


FIG. 373.—Pressure regulator.

mist spray, a type that is coming into use. French and Crafts¹ recommend a hole in a concave-grooved disk to secure uniform flat fan-shaped

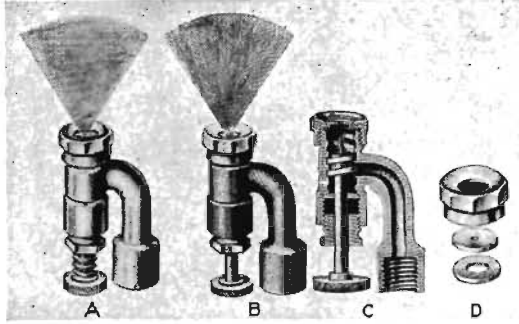


FIG. 374.—Vermorel spray nozzles: A, regular vermored nozzle; B, graduate vermored nozzle; C, sectional view of B; D, open cup, removal spray disk and packing ring for nozzle B.

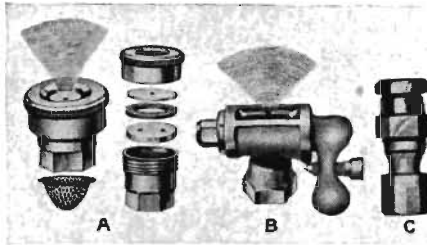


FIG. 375.—Disk, Bordeaux, and self-cleaner spray nozzles.

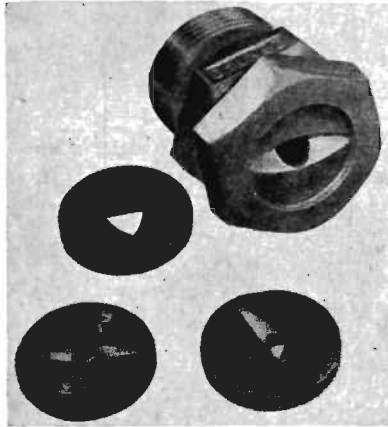


FIG. 376.—Nozzle for producing a flat spray.

spray for spraying weeds. The disk is placed in the nozzle with the concave side out. Where several nozzles are used on a boom the grooves are aligned so that the fan spray of every second nozzle meets.

¹ *Agr. Eng.*, Vol. 17, No. 3, p. 115, 1936.

PART VIII

HARVESTING MACHINERY

CHAPTER XXII

HAY HARVESTING MACHINERY

Hay harvesting machinery consists of all the tools necessary in the handling of the hay from the time of cutting until it is placed in the barn or baled. Machines included are: mowers, tedders, rakes, loaders, stackers, forks, carriers, and presses. These will be discussed in the order in which they are used in the process of making hay.

MOWERS

The mower is designed to cut grass for hay; however, it has various other uses. It is built in various sizes to suit almost any condition. The size is an influencing factor in determining the type, which may be one-horse, two-horse regular, or heavy and tractor mowers, the last named being mostly power-take-off types.

Most horse-drawn mowers are classed, either as a *plain lift* or a *vertical lift*, see Art. 415.

397. Frame.—The frame (Fig. 377) which may be considered the foundation of the mower, is cast in one piece and made of cast iron. Cores are placed in the mold to provide openings for the main axle, crank shaft, countershaft, and other parts. Holes are provided for lubrication. Since it is made of cast iron, it is cheaper than if made of steel, yet it is compact and strong and adds weight to the mower so that better traction may be had with the ground at all times. The heavy cast iron gives a rigid construction and will not allow the shafts and gears to get out of alignment.

398. Wheels.—All mower wheels are made of cast iron. The average height is 32 inches. The width of tire will vary from 3 to 4½ inches. Upon the face of the tire are lugs to aid traction with the ground for transmitting power to the cutting mechanism and prevent slipping sideways (Fig. 378). Wheels equipped with rubber tires can be obtained on special order (Fig. 379).

The ratchet and pawls are in the hub of the wheels. The ratchet is placed on either the inner or the outer end of the hub. One method is

about as common as the other. The pawls are fastened loosely or riveted to a pawl plate which is keyed rigidly to the axle. When the

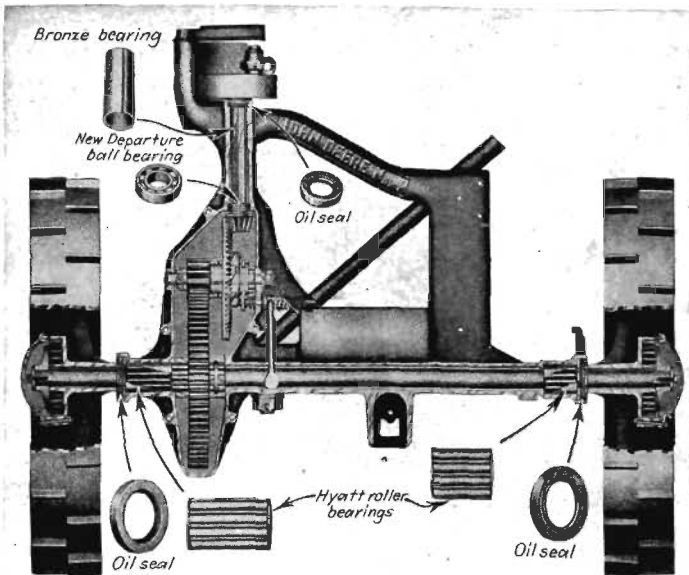


FIG. 377.—Mower frame showing enclosed gears and automatic lubrication of main operating parts. Note bearing and oil seals on axle line and pitman shaft.

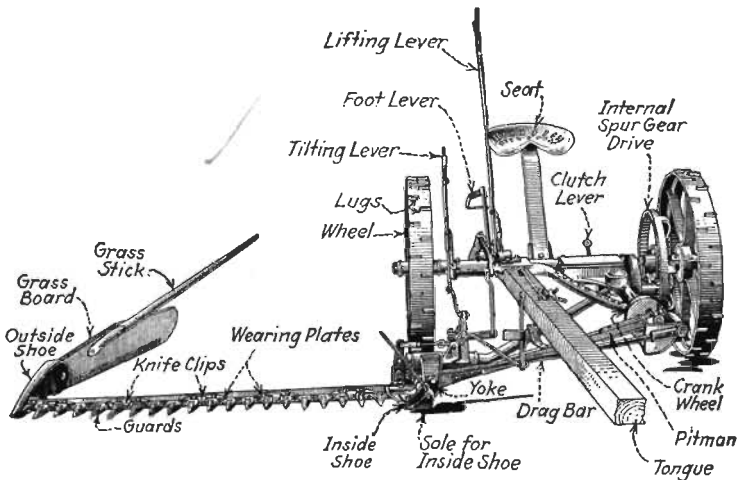


FIG. 378.—Complete mower with cutter bar in cutting position

wheel is turned forward, the pawls engage the ratchet teeth and cause the axle to turn as a unit with the wheel. When the wheel is turned backward, the pawls slip over the ratchets giving the clicking noise so

noticeable in the operation of a mower. The ratchet and pawls transmit the power from the wheels to the main axle. There should be at least three pawls to each hub and no two of them should engage at the same time. They should be so arranged that they will engage immediately when the wheel starts turning. This prevents the mower moving forward any distance before the knife starts.

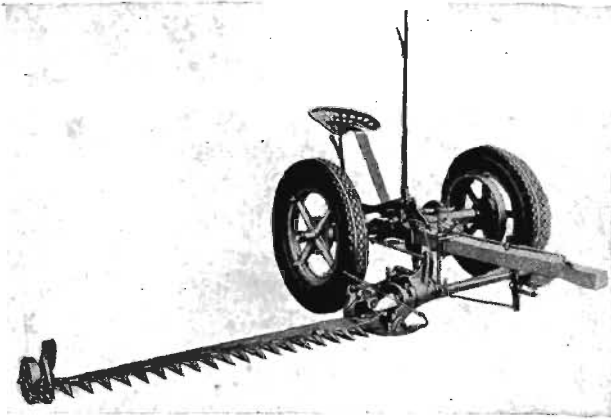


FIG. 379.—Mower equipped with rubber tires.

399. Main Axle.—The main axle consists of one long, straight, steel shaft extending through the frame from one side to the other. It is provided with keyways for gears and holes for pins to hold the pawl plate and wheels in place. Its length and size depend upon the size of the mower (Fig. 380).

400. Gears.—Practically all mowers have the power transmitted from the axle to the cutting mechanism by means of gears (Fig. 381). The

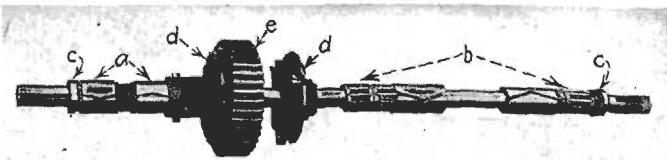


FIG. 380.—Mower axle and parts: A, B, roller bearings; C, leather oil seal; D, pawl and pawl holder; E, drive gear containing ratchets.

common method of arranging these gears is to have a large internal or external spur gear keyed to the main axle and placed next to the left wheel. Then, meshing with the gear is a small spur gear which is placed on the end of the countershaft. The countershaft extends across a special gear case which is a part of the frame and upon it is placed a rather large bevel gear which, in turn, meshes with a small bevel gear on the rear end of the crank shaft. The bevel gears are inclosed in a

gear case to keep dust and grit from collecting on them. There are only two steps in the transmission of the power through these gears, one with the spur gears and the other with the bevel gears. This arrangement will allow the crank wheel to revolve about twenty-five times for each revolution of the drive wheel.

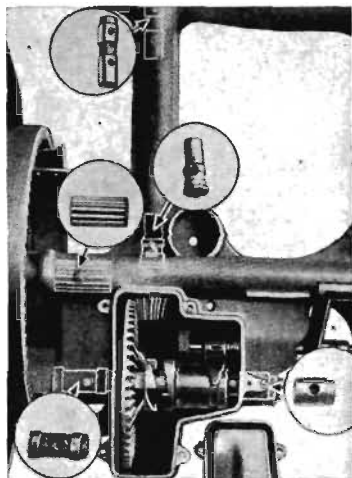


FIG. 381.—Gear transmission of a mower, showing spur and bevel gears, clutch, bearings, and bushings. The bevel gears run in an oil bath, which is enclosed and dust proof.

and, of course, will allow the mower to move forward slightly before the knife starts. Figures 381 and 382 show the clutch and gear assemblies for two mowers.

402. Crank Shaft and Crank Wheel.—The power is transmitted through the spur gears to the bevel gears on the end of the crank shaft and is, in turn, transmitted through the crank shaft and crank wheel to the pitman. The crank wheel is much heavier on one side than on the other, or it is counterbalanced. The heavy part of the wheel is opposite that on which the wrist pin is fastened. As the crank wheel revolves, it gives a reciprocating motion to the pitman and it is at this point that the rotary motion is changed into a reciprocating motion.

The bronze bushings, which serve as a bearing in the lower end of the crank shaft and on the wrist pin, must be examined frequently for wear. If there is any considerable amount of play, the bushings should be

401. The Clutch.—There are two methods of arranging the clutch on mowing machines so that the cutting mechanism can be thrown in and out of gear whenever desired.

One method is to place the clutch on the main axle and to the left of the center. The clutch gear resembles very closely a bevel gear with teeth set at an angle to mesh with another gear of the same type with the teeth set in the opposite direction. There may be as many as 22 teeth in each of these gears so that, when they are placed together, there is no lost motion. The other arrangement for the clutch is to place it on the countershaft which is to the rear of the main axle. The clutch on the countershaft has only about four teeth with which to engage,

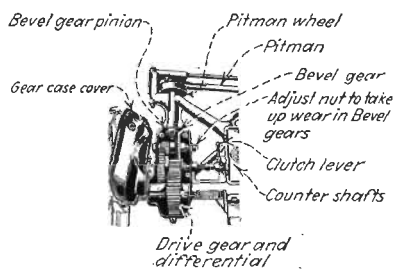


FIG. 382.—Mower transmission showing triple gear speed step-up.

replaced with new ones. Whenever this is done the shaft and wrist pin should also be examined for wear.

403. Bearings.—Many mowers have roller bearings on each end of the main axle, on the countershaft, and sometimes on the rear end of the crank shaft, but none is ever used on the front end of the crank shaft. At this point a bronze bushing is used because of the speed and reciprocating action necessary to operate the pitman and knife. In most cases a bronze bushing is used on the rear end of the crank shaft because the vibration of the front end is transmitted to the rear end. A bronze bushing is also used in the pitman boxing which fits on the wrist pin on the crank wheel.

404. Pitman.—Power is transmitted from the crank wheel to the knife by a pitman. It is usually made of wood, though steel may be used.

A pitman box fits over the wrist pin which extends out from the crank wheel. Figure 383 shows that the pitman box has an extension on one side with countersunk holes for the pitman straps to fit into. This connection should be kept reasonably tight to prevent excessive play but allow the pitman to align itself with the pitman box. The pitman box usually has a bronze bushing. The bearing must be thoroughly lubricated at all times. Grease cups, oil cups, or pressure fittings are provided.

The pitman is connected to the knife head by sockets fitting over the knife head ball. This connection should also be kept tight enough to prevent lost motion between the straps and the ball. Some pitmans are provided with a spring that automatically takes up the wear and holds the connection tight.

405. Mower Sizes.—The size of the mower is determined by the length of the cutter bar or the width of the swath it will cut. If the mower will cut a swath 5 feet wide, it is called a 5-foot mower. The average size for two horses is the 5-foot mower. However, the size may range from 4 to 7 feet. There are some made suitable for one horse, having a cutter bar only $3\frac{1}{2}$ feet in length. Such mowers are good for small yards, lawns, parks, and orchards. Instead of having poles, as in the case of the two-horse type, thills are provided.

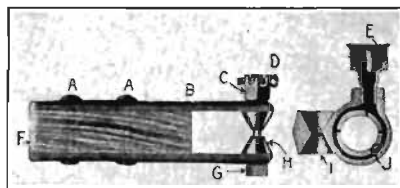
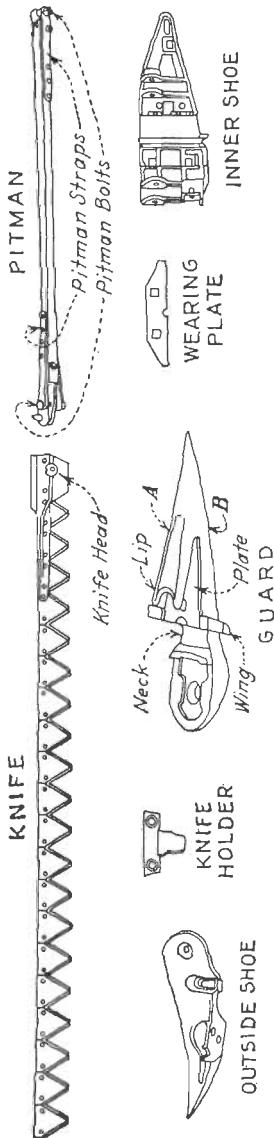


FIG. 383.—Pitman straps and pitman box: A, rivets; B, pitman straps; C, nut; D, cotter key; E, grease cup; F, pitman; G, pitman bolt; H, conical pitman-strap connections; I, countersunk connection for pitman straps; J, bronze bushing.

CUTTER BAR AND ITS PARTS

For the knife to do its work, it must have aid from a number of other parts which go to make up the cutting mechanism (Fig. 384). These consist of the cutter bar, inside shoe, outside shoe, guards, ledger plates, wearing plates, knife clips, grass board, and stick.

406. The Cutter Bar.—The cutter bar (Fig. 385) is made of high-grade steel. All other parts included in the cutting mechanisms are connected directly or indirectly to it.



*NOTE: When Aligning Guard,
Strike at Points A and B*

FIG. 384.—Various parts of a cutter bar with knife and pitman.

407. The Inside and the Outside Shoes.—A large shoe-like runner (Fig. 385) supports the inner end of the cutter bar when in operation. A removable sole is placed underneath the shoe which is adjustable to regulate the height of cut. The outside shoe (Fig. 385) supports the outer end of the cutter bar. It also has an adjustable sole to regulate the height of cut. The pointed front part of the outer shoe acts as a divider, separating the cut from the standing grass.

408. The Guards.—The guards serve to protect the cutting units (Fig. 384). They also provide a place for the ledger plates. They divide the material being cut so that the cutting units can do the best work. If any of the guards get out of alignment, they should be hammered back in place. Special grain or pea- or bean-vine lifters are often used to facilitate the cutting of fallen material.

409. Ledger Plates.—The ledger plates are riveted to the guard (Fig. 386). They form one-half the cutting unit, the knife sections acting as the other half. The edges of the ledger plates are serrated to prevent stems of grass from slipping off the point of the shears. When the ledger plate becomes worn and dull, it should be replaced with a new one. Figure 387 shows a special anvil for removing and replacing ledger plates and knife sections.

410. Wearing Plates.—Wearing plates (Fig. 384) are necessary to support the rear side of the knife. When they become

worn, the rear side of the knife will drop down, causing the sections to kick up and not make close contact with the ledger plates. Heavy draft and poor cutting will result from such a condition. The wearing plate under the knife head should not be overlooked when repairing a mower.

411. Knife Clips.—Knife clips or holders (Fig. 385) are essential to hold the knife sections down close against the ledger plates. If they become worn and allow the knife to play up and down, making poor contact with the ledger plates, they should be hammered down. They are made of either malleable iron or steel.

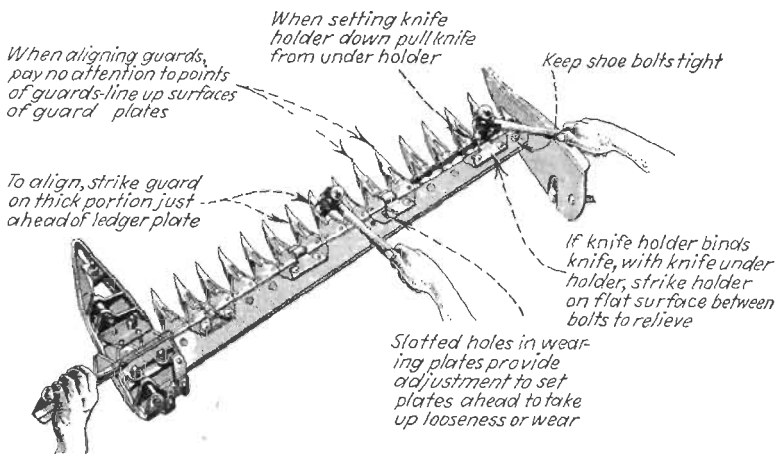


FIG. 385.—Complete mower cutter bar, with instructions for adjustment of parts.

412. Grass Board and Stick.—These parts are attached to the outer shoe. The board with a yielding spring connection angles back away from the uncut grass. Its purpose is to divide and rake away the cut from the uncut grass, to give a clean place for the inside shoe on the next

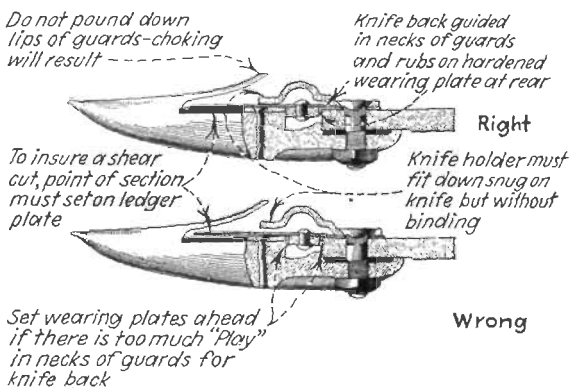


FIG. 386.—Right and wrong way for a mower knife to fit and operate in the guards.

round. For long and tangled material a *rotary* grass board can be secured that will leave a cleaner swath than the regular type.

413. Alignment of Cutter Bar.—To do the best work with a mowing machine, it is essential that the center of the pitman box, the knife head, and the outer end of the knife bar be in a straight line *when operating*.

When not in operation, however, the outer end of the bar, when in cutting position, should be a little in advance of the inner end to offset the backward strain produced by the pressure of the cutting and to permit the knife and pitman to run in a straight line. This setting is called *lead*.

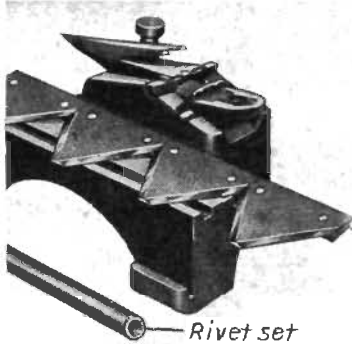


FIG. 387.—Special anvil for removing and replacing ledger plates and knife sections.

The outer end of the bar should be ahead of the inner end 1 to $1\frac{1}{4}$ inches on $4\frac{1}{2}$ -foot mowers; $1\frac{1}{4}$ to $1\frac{1}{2}$ inches on 5-foot mowers; and $1\frac{1}{2}$ to $1\frac{3}{4}$ inches on the 6- and 7-foot sizes.

Figure 388 shows a method of measuring to determine the proper lead for the cutter bar.

The inset in Fig. 388 shows how an eccentric bushing can be used to adjust the lead for a cutter bar.

414. Registration.—This means that each section of the knife should center with the center of each guard, when the knife is at the extreme end of its in-and-out strokes (Fig. 385). Failure to register is a very common trouble in mowers and should be looked for often. The results of failing to register are: an uneven job of cutting, and an uneven load on the entire mower, heavier draft, and, often, clogging of the knife. When an attempt

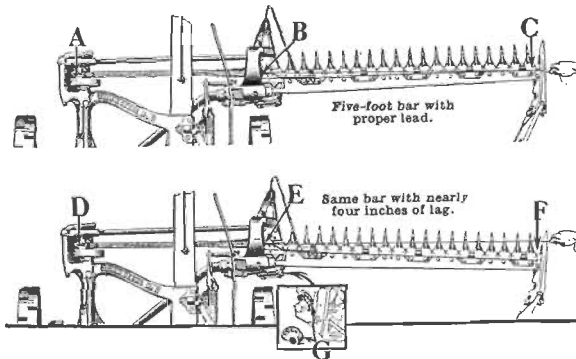


FIG. 388. —Illustrating how to measure the lead of a cutter bar for proper alignment. Point C should be from 1 to $1\frac{1}{4}$ inches ahead of points A and B. Points D, E, and F show a cutter bar with too much lag.

is made to align the cutter bar by lengthening or shortening the drag bar, it may, at the same time, disturb the registration of the knife sections with the guards. To adjust registration, the whole cutter bar, including the inside and outside shoes, is moved in or out.

415. Cutter-bar Lifts.—There are two ways of raising the cutter bar to a vertical position. If the operator is required to get off the seat and

take hold of the outer end of the cutter bar and lift it up and fasten it in a vertical position, it is called a *plain* or *regular* lift.

The popular type of lift is where the operator remains in the seat and, with a lever, raises the cutter bar to a vertical position. When this can be done, it is called a *vertical* lift. The cutting mechanism is automatically thrown out of gear as the bar is raised. It is also thrown in gear when the bar is lowered. It is more convenient for use in stumpy ground, orchards, and where there are a number of obstructions. All mowers are provided with a foot lift so that the cutter bar can be raised for turning at corners and lifting the bar over very low obstructions.

SPECIAL ATTACHMENTS

The mowing machine is often required to cut under difficult conditions and to perform special work. Attachments to facilitate doing such jobs are mentioned briefly

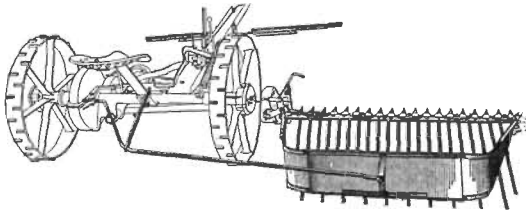


FIG. 389.—Bunching attachment.

416. The Bunching Attachment.—This attachment consists of a number of finger-like bars extending to the rear of the cutter bar and having a special hood-like arrangement that attaches at each side and around the rear ends of the fingers (Fig. 389). This hood is allowed to remain down until quite a bunch of hay has been collected and then is lifted by a foot lever, allowing the bunch of hay to slide off the bars.

417. The Reaping Attachment.—This attachment is used mainly for cutting clover for seed. It has an extra seat placed over the right wheel so that the operator can be closer to the cutter bar in order that he may use a rake to rake the clover off in bunches from a small wooden platform made out of wooden slats (Fig. 390).

418. Grain, Pea, and Bean Lifters.—These lifters consist of guards which are attached over the regular guards projecting to the front quite a distance, so that pea and bean vines can be lifted, allowing the cutter bar to slide underneath and cut off the stems below the heads (Fig. 391).

419. Weed Attachment.—This attachment consists of a wheel placed at the outer end of the cutter bar to carry it some 6 to 12 inches off the ground, so that the weeds may be cut without undue strain upon the mower parts.

420. Weed and Brush Bars.—These bars are constructed with stub guards instead of the long sharp-pointed guards used for cutting grass. Extra-heavy knives are also used with them.

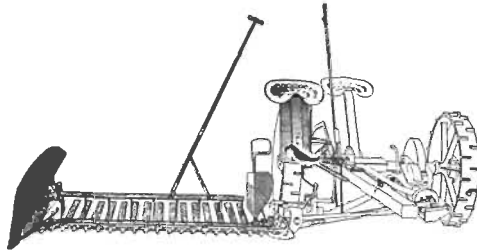


FIG. 390.—Reaping attachment for mower.

421. Windrowing Attachment.—The windrowing attachment consists of a number of bars attached to the cutter bar, curved upward at

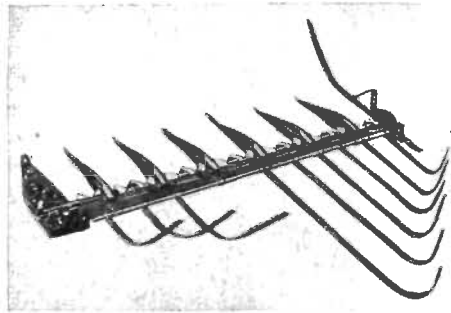


FIG. 391.—Pick-up guards and center windrow used in harvesting canning peas.

the rear end. The bars are about 3 feet in length at the outer end and gradually increase in length toward the inner end where they are some 8 feet long (Fig. 392). The hay is allowed to slide to the side into a

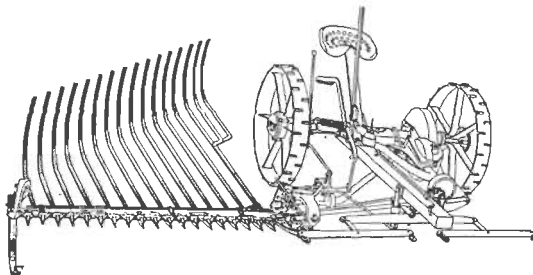


FIG. 392.—Side-delivery windrowing attachment.

windrow. Some of these attachments can be folded to allow bunching. The windrow attachment is especially adapted for harvesting flax, clover, alfalfa, peas, and other crops.

422. Bermuda-grass-cutter Bar.—Another special type of cutter bar being made has twice as many guards as on the regular type. These guards are narrow, having ledger plates on each guard, and are so placed that the knife, in making an in or out stroke, passes through two guards

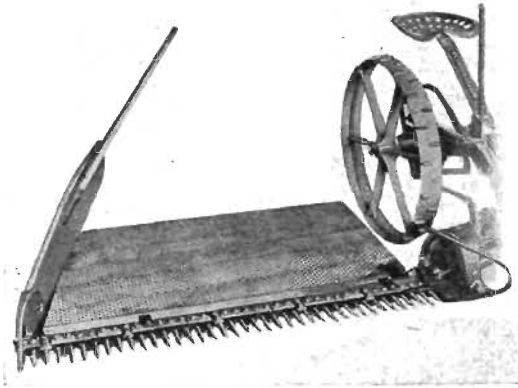


FIG. 393.—Lespedeza bar and special pan for receiving the seed that are shelled in the process of cutting.

instead of one. It is claimed that this arrangement is effective in cutting Bermuda grass which becomes very closely matted together.

423. Lespedeza Bar.—Figure 393 shows a cutter bar equipped with special narrow guards, a seed screen, and a pan to receive the seed.

424. Tongue Truck.—Tongue trucks on a mower take the weight of the tongue off the team, prevent whipping of the tongue on rough ground, and reduce side draft (Fig. 394).

MOWER TROUBLES

425. Draft.—Excessive draft on a mower may be caused by:

1. Dull knives.
2. Worn ledger plates.
3. Poor lubrication.
4. Non-alignment of cutter bar.
5. Non-registration.

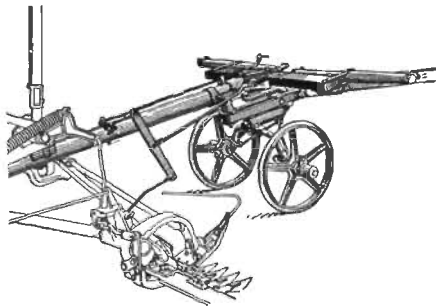


FIG. 394.—Tongue truck for mowers.

Duffee, of the University of Wisconsin, found in his experiments on the draft of mowers under field conditions that the condition of the cutting parts was the most important factor. Table XIII shows the effect of dull and sharp knives and dull and sharp ledger plates.

A study of the table shows that when the knives were dull and the ledger plates in poor adjustment, draft was increased 30 to 35 per cent. Very little was gained by sharpening the knife and leaving the ledger

TABLE XIII.—RESULTS OF DRAFT TESTS ON A 5-FOOT MOWER TO DETERMINE THE EFFECT OF SHARP AND DULL KNIVES AND SHARP AND DULL GUARDS¹

Condition of cutter bar	Total draft, pounds	Increased draft, pounds	Per cent increase	Speed in miles per hour	Horse-power required to pull mower
Bar in first-class condition, new and sharp.....	297	...	....	2.5	1.98
Bar in very poor condition, guards dull, wearing plates worn, knife fairly sharp.....	396	99	33.3	2.5	2.64
Bar in good condition, except knife one-quarter dulled.....	305	8	2.7	2.5	2.03
Bar in good condition, except knife one-half dulled.....	318	21	7.1	2.5	2.12
Bar in good condition, except knife three-quarters dulled.....	367	70	23.6	2.5	2.45
Bar in good condition, except knife fully dulled.....	398	101	34.0	2.5	2.66

¹ "Farm Mechanics," p. 12, 1921.

plate in poor adjustment. These tests show the advantage of the sharpened knife and a properly adjusted cutter bar, with ledger plates in good condition. Figure 395 shows a special knife grinder.

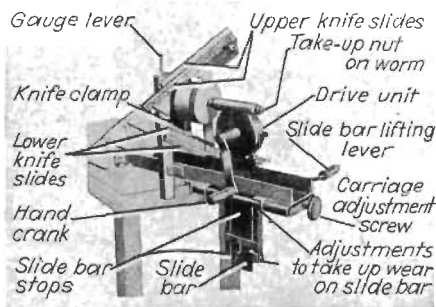


FIG. 395.—Knife grinder that can be operated with hand or foot power, electric motor, or gas engine.

426. Side Draft.—Side draft on mowers is a tendency for the machine to pull around towards the side on which the cutter bar is placed. An extra long cutter bar will sometimes, within itself, cause side draft due to the long leverage to the side; the average small mower may also give a certain amount of side draft. In these mowers it is usually caused by the

failure to cut clean, which allows the grass to pull under and the cutter bar to slide over without cutting the grass at all. If the knife or ledger plates become dull, hard cutting will result, which, at the same time, will cause considerable side draft; but if the mower is properly adjusted and all parts in good condition, there should be very little side draft.

427. Breaking of Knives.—A common trouble in mowers is that of breaking the knives at a point where the knife-head strap ends. This trouble may be caused by badly worn knife-head holders on the inside

shoe, by non-alignment, and by undue play in the pitman box bearings. When the inside shoe parts become badly worn, the knife is allowed to play up and down as the pitman draws and pushes it backward and forward. As the pitman draws the knife in, it naturally pulls the head up and when it pushes it out, the pressure is down against the plate. If there is much wear at this point, therefore, the knife head will have considerable play up and down and will, in time, break the knife bar.

Non-alignment is often considered another cause for breaking the knife because it is working at an angle.

When the pitman box bearing becomes worn, allowing considerable play within the bearing, there will be a decided jerk and pounding as the knife reaches the end of its out-and-in strokes. This will weaken the knife bar and finally break it.

428. Lost Motion.—After a mower has been used for some length of time, lost motion may occur in the parts transmitting power from the main wheel to the knife. The machine may be started forward and moved several inches without the knife starting. The places where lost motion may develop are as follows:

1. In the hubs of the wheels where the pawls engage the ratchet.
2. In the clutch.
3. The various gears.
4. In the pitman wheel bearings.
5. At the knife head.

The parts involved should be examined frequently and steps taken to eliminate as much lost motion as possible.

429. Acres Cut per Day.—The acres cut per day will naturally be influenced by several factors, such as: material being cut, size of machine, condition of machine, and speed.

The "Extension Service Handbook"¹ gives the duty of a mower for a 10-hour day as 1.68 acres per foot of width of cut. It also gives 2.50 feet as the most usual width per horse.

A good day's work with a 7-foot machine is 13 to 15 acres per day.² With a 5-foot mower, the cost per acre for man and horse labor will be around 50 cents.

430. Power Mowers.—The power mower is a specially designed attachment for general purpose tractors (Fig. 396). The cutting parts are practically of the same construction and require the same care and adjustments as do horse-drawn mowers. Power for operating the knife is transmitted from the power take-off to the pitman through a drive shaft.

¹ "Extension Service Handbook on Agriculture and Home Economics," U. S. Dept. Agr., 1926.

² U. S. Dept. Agr. Farmers' Bull. 943, p. 8, 1921.

The speed of the drive shaft is reduced by either gears, sprocket and chain, or V-belts. The speed of the knife may be in proportion to the



FIG. 396.—Mowing hay with tractor mower attachment driven from power take-off.

travel of the tractor or it may be in proportion to the engine speed. Usually a slip clutch in the power line releases automatically when the

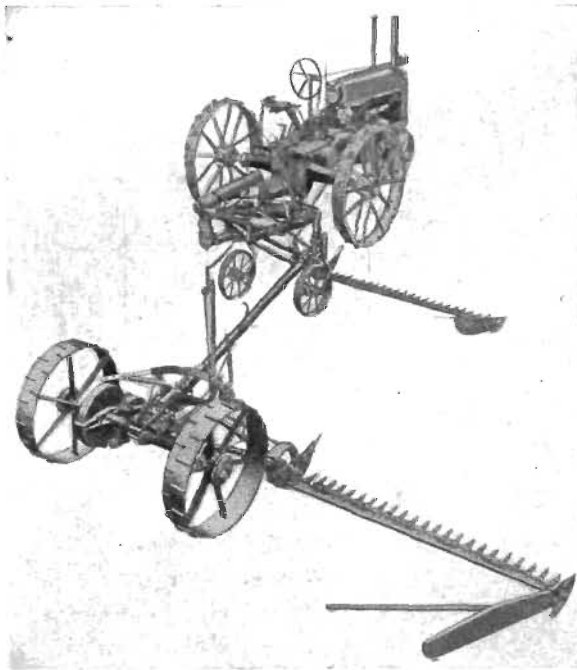


FIG. 397.—Power mower and trailer mower attached to general purpose tractor.

knife chokes or the cutting becomes too heavy. If the cutter bar strikes an obstruction, it will swing back and prevent damage to the mower.

431. Trailer Mower.—The trailer mower is a ground-driven mower designed for use behind tractors. It can be used singly, in series, or as a trailer behind a power mower, as shown in Fig. 397. The whole machine is of extra-heavy construction and has special gears that permit efficient operation at tractor speeds. Safety spring-release hitches (Fig. 398) are provided to release the mower from the tractor if an obstruction is hit.



FIG. 398.—Cutaway view of spring-release safety hitch for mowers. The spring compresses, permitting the latch rod to disengage and release mower from tractor.

HAY TEDDERS

Where a heavy growth of hay is cut, it will be so thick in the swath that the upper leaves and stems which are exposed to light and the air will cure while the hay underneath will still be green. To secure uniform curing of the hay, it is necessary that it be stirred so that the hay will be left in such condition that it will cure uniformly from the top to the bottom.

432. The Tedder.—This machine consists of a wide frame mounted on wheels somewhat on the order of a sulky hay rake, but instead of having a straight rake, as in the case of the dump rake, the tedder is provided with forks (Fig. 399). The number of forks may vary from six to

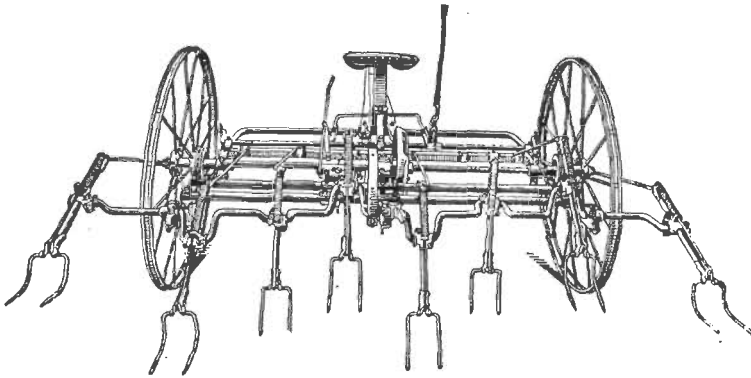


FIG. 399.—Hay tedder.

eight according to the width of the machine. These forks are attached to a crank shaft which has the crank throws arranged irregularly so that only two or three of the forks are engaging the mown hay at the same time. The forks are made of spring-steel teeth and are attached to fork arms having a spring trip, so that if the fork gets in behind an obstruction, it will break back relieving the strain on the arm, shaft, and driving mechanism. The crank shaft is placed to the rear of the frame and the wheels, and extends out to each side beyond the wheels, providing a place for the attachment of the fork outside of the wheels. This is done so

that it will not be necessary to run the wheels on the hay that has already been teded, thereby mashing it down and undoing the work the machine has done.

There are two methods of transmitting the power from the wheels to the shaft. Some of the tedders have the shaft in one piece, while in others it is divided in the center. If it is of one piece, it is very likely to be driven by gear or by sprocket and chain from the main axle, but if the shaft is divided in the center each half is run by gear or by sprocket and chain taken directly from the hub of each wheel. Then, each wheel is called upon to run one-half of the machine.

HAY RAKES

Hay rakes may be classified as follows:

- I. Windrows rakes:
 - 1. Dump types:
 - a. Hand dump.
 - b. Power dump.
 - 2. Side-delivery types:
 - a. Cylinder.
 - b. Fork.
- II. Bunching or sweep rakes:
 - 1. Side-hitch type:
 - a. Two wheel.
 - b. Three wheel.
 - 2. Rear-hitch type:
 - a. Three wheel.
 - b. Four wheel.
 - 3. Tractor sweep rakes.

433. Dump Rakes.—This type of rake, shown in Fig. 400, is also known as a *sulky* hay rake. The principal difference between a hand rake and a power-dump rake is that with the former the operator must furnish

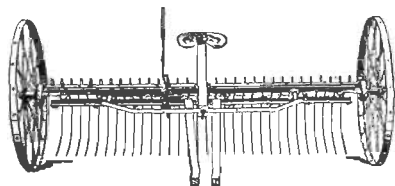


FIG. 400. Power-dump hay rake.

the power for lifting the teeth to dump the hay, while in the latter the operator merely presses a small foot lever which engages pawls in the hubs of the wheels. Then, as the rake is drawn forward, the power furnished by the team lifts the teeth. The pawls are automatically released when

the teeth have been raised. Specially constructed dump rakes may be had for use in orchards to rake up the branches or trimmings after pruning.

434. Side-delivery Rakes.—The use of hay loaders created a demand for a hay rake that would make a loose, fluffy, continuous windrow. Then too, many haymakers are raking the hay into windrows directly after it is cut. Such windrows must necessarily be loose to allow the hay

to cure. The side-delivery rake was developed to take care of this demand. There are two types of these rakes, namely, the *cylinder* and the *fork* types.

The *cylinder* type is shown in Fig. 401. It consists of a cylinder of three rake bars placed at an angle of about 45 degrees with the direction

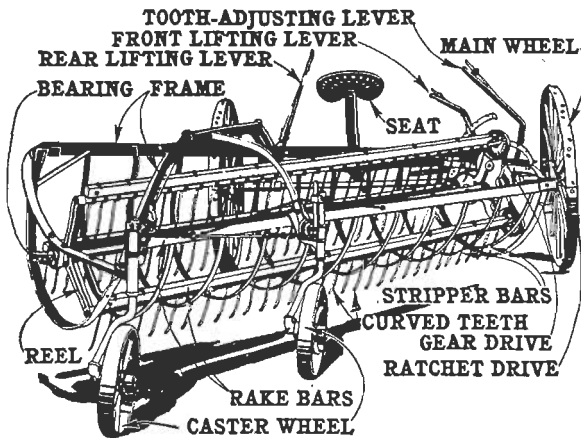


FIG. 401.—Cylinder-type side-delivery hay rake.

of travel. The delivery is made to the left so that the direction of travel is the same as that of the mower. This makes the rake teeth work against the heads of the hay, rolling them to the inside of the windrow. The more juicy stems are left on the outside. Some side-delivery rakes are con-

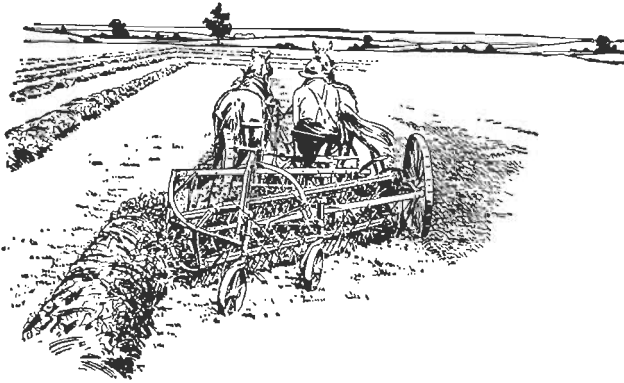


FIG. 402.—Cylinder-type side-delivery hay rake in operation.

structed so that the rotation of the cylinder can be reversed and the rake be made to do the work of a hay tedder.

The *fork* type of side-delivery rake differs from the cylinder type, since it has a number of large forks placed on an irregular bent shaft which allows the forks to follow one another in their work of raking hay.

435. Bunching or Sweep Rakes.—For the rapid handling of the hay from the windrow to the baling press or stack, a bunching or sweep rake, sometimes called a *buck*, or *bull rake* is a labor and time saver, as well as a cost-reducing tool. As indicated above, there are several kinds of sweep rakes.

The *side-hitch* sweep rake has one horse hitched on each side of the machine beside the teeth. The teeth are 7 or 8 feet in length placed

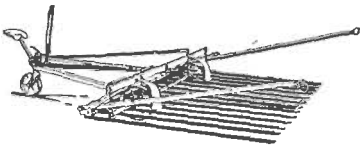


FIG. 403.—Side-hitch three-wheel sweep rake.



FIG. 404.—Rear-hitch four-wheel sweep rake.

about 1 foot apart, and are made of wood. These long teeth are lowered upon the ground and slide under the hay until a load has been collected. Then, in most cases, the teeth and hay are raised off the ground, the whole weight being carried on the wheels.

The *two-wheel* type allows the operator to slide the seat backward and forward to help balance the rake teeth and the load.

The *three-wheel* type, shown in Fig. 403, has the seat mounted on a rear truck consisting of one wheel which castors in any direction. A lever is provided to raise and lower the teeth.

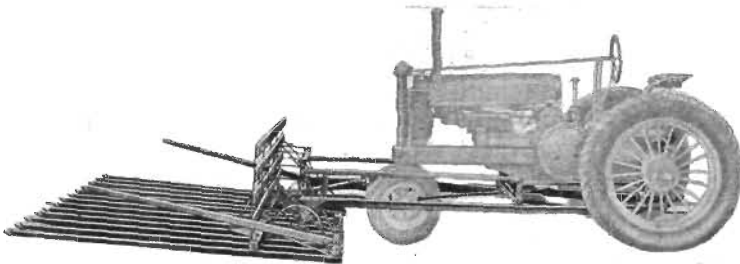


FIG. 405.—Tractor sweep rake.

The *rear-hitch* sweep rake has the team hitched back of the rake head. The rear truck supporting the seat and eveners may have one or two castoring wheels. Figure 404 shows a four-wheel rear-hitch type. The horses are hitched at the rear, one on each side of the truck.

The rear-hitch sweep rake is better suited for heavy hay and is so constructed that it will pass over small irrigation ditches without difficulty. However, some haymakers prefer the side-hitch type for rough ground.

Many of the rear-hitch sweep rakes are provided with power lifting devices so that the operator is not required to lift the rake teeth and hay

entirely by hand levers; after the teeth have been raised by the power device, they are automatically locked in place so that the hay can be carried some distance.

436. Tractor Sweep Rakes.—Sweep-rake teeth are mounted on the front of the tractor (Fig. 405). The raising and lowering of the teeth are operated by power from the tractor.

HAY LOADERS

To facilitate the rapid handling of hay and to eliminate a great deal of hand and manual labor, the hay loader was brought out for taking the hay either out of the windrow or directly out of the swath and elevating it up onto the wagon.

There are two general types of hay loaders: the *cylinder*, which may be single or double, and the *rake-bar* or *fork* type. These machines are attached to the rear of the wagon and driven over the windrow or along the swath from which they gather the hay, loading it onto the wagon. Loaders may be had with or without a forecarriage. If no forecarriage is used, the machine is balanced on two drive wheels and the front part is carried by the rear axle of the wagon.

It is claimed that a hay loader,¹ under ordinary conditions, will increase the capacity of a crew about 30 per cent over that of the same crew pitching the load by hand forks.

437. Fork Loader.—The loader shown in Fig. 406 is often called a *swath* loader because it is not necessary to rake the hay before using the machine. It will rake and load hay all in the same operation. It will, however, do good loading from the windrow. This loader has two sets of wooden bars operated alternately by a cranking motion from the drive wheels. At the end of each of the wooden bars are claw-like rakes that gather the hay from the windrow or swath, pulling it up on a slatted inclined apron which extends up over the rear of the wagon or rack. At intervals along each of these bars are flexible-wire teeth which extend downward to catch the hay and move it up the incline as the bars are worked backward and upward. While one set of these rake bars are gathering the hay from the ground and pushing that already gathered up the incline, the other set is raised upon its crank above the hay and moved back down for a new movement upward. The hay is pushed little by little up the incline until it falls on the load.

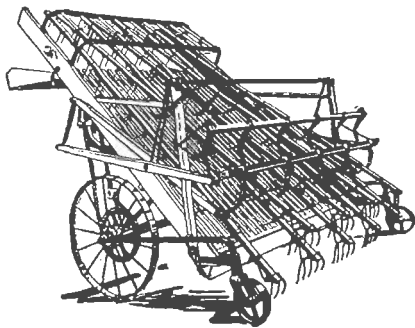


FIG. 406.— Fork-type hay loader.

¹ McCURE, H. B., "Hay Making," U. S. Dept. Agr. Farmers' Bull. 943, p. 16, 1921.

438. Cylinder Hay Loader.—This type of loader shown in Fig. 407, is often known as the *windrow loader*, *endless apron*, *elevator*, *belt*, *web*, or *drum* type, so-called because of the cylinder for gathering the hay and the elevator for elevating it.

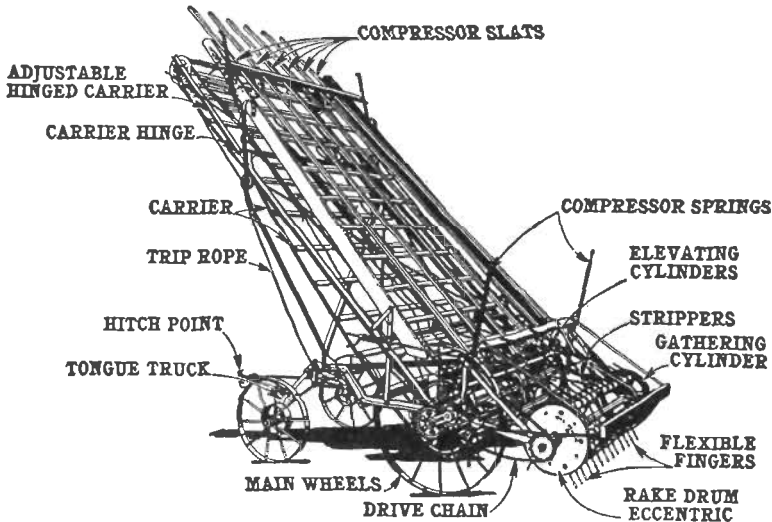


FIG. 407.—Cylinder hay loader with gleaning cylinder attached.

The cylinder consists of a number of shafts rigidly fixed and placed an equal distance apart around the circumference of the cylinder head. Upon each of these shafts are tine-like teeth having a peculiar curve and

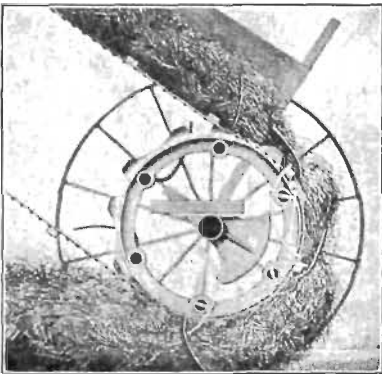


FIG. 408.—This illustration shows how the cylinder-type hay loader picks up hay and deposits it on the elevating carrier.

given three or four turns around the shaft for flexibility. This cylinder revolves in the same direction that the drive wheels are revolving, and the teeth have an action similar to that of an ordinary hand pitchfork, bringing the hay up and over from the rear, depositing it on the web-slatted apron, which elevates it on to the wagon. The elevator or apron is made up of wooden slats placed about 12 inches apart, connected by strands of rope, and driven by chains at either end from the main drive wheel below.

When the loader is attached to the rear axle of the wagon, there should be an automatic release which can be operated from the top of the load by pulling a trip rope, thus saving time by not having to get down off the load and unhook the loader.

439. Gleaning Cylinder.—To make sure that the hay is raked clean from the windrow, another cylinder is attached to the rear of the main raking cylinder to act as a gleaner. It may be called a *double-cylinder* loader (Fig. 407). This auxiliary cylinder revolves in a direction opposite to that of the main cylinder and does a good job of gleaning the hay left by the main cylinder.

440. Combination Cylinder and Rake-bar Loader.—This hay loader combines the principles of both the cylinder and the fork or rake-bar loaders. It retains the rake bars for elevating the hay but makes use of a cylinder for picking up the hay from the windrow (Fig. 409). The tight bottom prevents loss of shattered leaves, and the rake bars permit satisfactory loading in windy weather.



FIG. 409.—Combination cylinder and rake-bar hay loader in operation.

441. Hay Racks.—For hauling hay to the barn or stack, special hay wagons or racks are necessary. It is not possible to use the ordinary wagon box for hauling a great amount of hay because only a small quantity can be loaded on. For this reason a frame is built to set on the wagon gears. It extends to the side over the wheels and is much longer than that of the ordinary wagon box. At each end of this rack are placed frames which are inclined outward. Such frames will accommodate twice as much hay as can be put on an ordinary wagon box. This type of hayrack is used to a considerable extent in all the hay sections. They either can be bought commercially, or can be built locally. Some of these racks have boards or slats on the sides for the hauling of short hay where there is considerable wind.

There is a second type of hay rack which, instead of being placed on an ordinary wagon gear, is mounted on wheels and is often called a *hay*

truck. The truck wheels are around 15 inches in diameter, so that the whole outfit is rather low. Some of these types of trucks have four wheels, while others have only two placed near the center so that the truck balances. A series of trucks can be attached together, each supporting the other. Such trucks are useful in sections of the country where there is heavy rainfall. The hay can be thrown on the trucks before it is cured and run under a shed out of the rain or a tarpaulin can be thrown over it to protect the hay.

HAY STACKERS

In some sections hay is stacked in the field rather than stored in the barn. Many types of stackers are built both commercially and locally.

442. Overshot Stacker.—The overshot stackers (Fig. 410) are so-called because the hay is carried up and over the stacker frame and

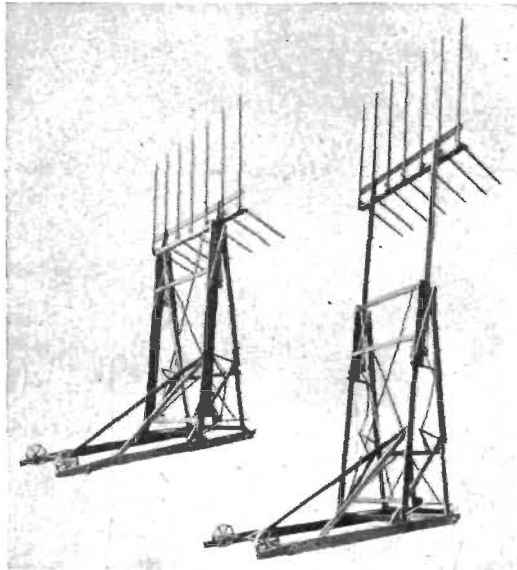


FIG. 410.—Overshot high-lift hay stacker, showing low- and high-lift positions.

delivered to the stack in very much the same way as the average man handles the pitchfork. The hay is brought up by the sweep rake; the stacker teeth are lowered to the ground and the rake teeth are driven with their load of hay to lap upon those of the stacker teeth. The sweep rake is then backed off, leaving the hay upon the stacker teeth where it can be elevated to the stack without any further trouble or handling. After the stack has become quite high, it is necessary that a considerable amount of hay be handled by hand to get it in position after being placed on the stack. This type of stacker may have a rigid frame extending from the

side next to the stack out to the stacker teeth, the whole of which is raised rigidly by means of ropes and pulleys. Another method is to have an incline which may be mounted upon wheels or on a wagon gear for elevating the stacker teeth. The stacker should be provided with springs or

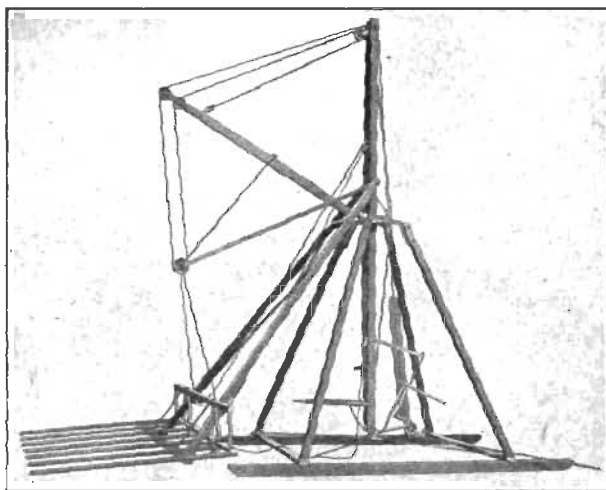


FIG. 411.—Swinging hay stacker.

weights to counterbalance the weight of the stacker head while the latter is returning to the ground. This allows the team to be backed as rapidly as they will without having to consider the return of the stacker head.

443. The Swinging Stacker.—This stacker (Fig. 411) is sometimes known as the *swing around* stacker. Instead of throwing the hay directly overhead it is raised and swung around to the side, where it is dropped at any place desired. This is quite an advantage over the overshot stacker. It reduces the amount of work required on the stack. The stacking head receives the hay from the sweep rake in the same manner as that of the overshot stacker. This type of stacker is also advantageous where there is considerable wind, which would interfere with that of the overshot type.

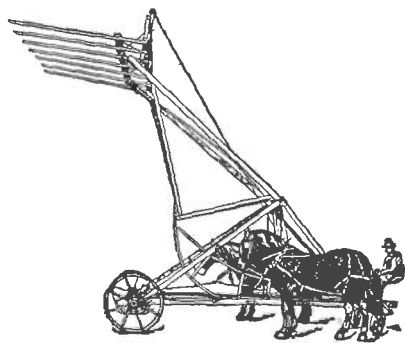


FIG. 412.—Combination sweep rake and stacker.

When it is desired that the load be dropped, a trip lever is pulled which allows the teeth to be tipped downward, dropping the hay in the desired place. When beginning the stack, it is necessary to elevate the hay only a

few feet and, as the stack increases in height, the load can be hoisted to a corresponding height.

444. The Combination Stacker.—The combination stacker (Fig. 412) consists of both a sweep rake and a stacker combined. It is used to take the hay from the windrow or cock and place it directly on the stack. The advantage over the overhead stacker is that the hay can be dropped at any convenient place on the stack.

445. The Cable Stacker.—The cable stacker, shown in Fig. 413, consists of two sets of two poles bolted together at the top and spread out at the bottom to form a framework for the cable to be stretched over and between. The cable forms a carrier track so that the hay can be carried to any place across the top of the stack. This is a similar

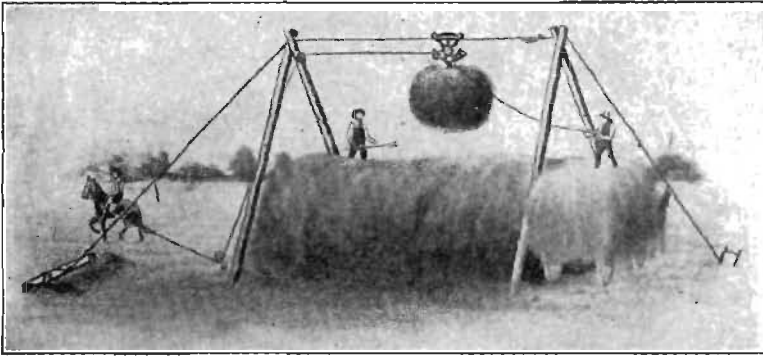


FIG. 413.—Cable hay stacker.

arrangement to what is had in the barn. Any height of stack can be built. The only limiting factor is the length of the poles used.

446. Derrick Stacker.—Such stackers may consist of one or two poles. The single-pole stacking outfit may have the pole placed in a leaning position so that the upper end will be above the stack. The pole can be set vertically with a cross-arm at the top extending out to the side from which the forks are suspended for elevating the hay. In this type, it is only necessary to turn the pole or derrick through 180 degrees to handle the hay. When turned away from the stack, it is in position to take the load and, when elevated, it is swung around in a semicircle over the stack where it is dumped.

The leaning type has an advantage over that of the perpendicular pole, in that it can be swung to any position along the stack. This will eliminate, largely, the handling of the hay on top of the stack.

447. The Tripod Stacker.—This stacker is a very simple arrangement consisting of three poles arranged to form a tripod and supporting each other; guy wires are not necessary to hold the poles in place. A pulley is suspended from the top, where the poles are bolted together, for the elevation of the hay.

HAY PRESSES

Where hay is being grown for commercial purposes and has to be shipped, it should always be baled so that as much as possible can be put into the average railway car. Many hay growers prefer to bale their hay and store it away in the barn to conserve the space. Hay presses may be divided into two classes according to the power used: horse presses which may be one- or two-horse, and the power presses which have power in the form of a gas engine mounted on the frame, or the power supplied from other sources by means of a belt.

448. Horse Presses.—When horse power is used, no matter whether it be the one- or two-horse type of press, the horses are hitched to a long lever pole called a *sweep* and are required to travel in a circle to operate the compressing mechanism (Fig. 414). Some balers have long

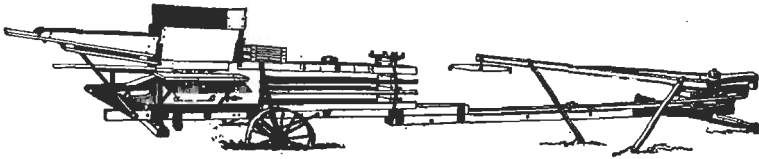


FIG. 414.—A one-horse pull-type hay press ready for use.

pitmans and operate by pushing the hay into a box. These are called *push plunger* presses. Others accomplish the same results by pulling and are called *pull plunger* presses. It is considered that the pulling type is better; it eliminates quite a bit of heavy construction. Some horse balers may have two strokes of the compressing mechanism to one complete round of the team, while others may have as many as three. The more strokes to the round, the more rapid the baling process will be. Many of these small horse-power presses are fed by hand, the hay being pressed down into the compressing chamber by hand power. Others have an arrangement where the power is supplied by the horses and have a special arm and feeder head to press the hay down into the box. Along with the self-feeder device there should be a *tucker* which prevents the bale from having what is known as *tails*.

449. Power Presses.—Presses that are run by engines are built much heavier than the horse presses (Fig. 415). The power presses are divided into those which have the power mounted on the frame in the form of a gas engine to furnish the power, and those operated by power not on the frame, such as a tractor. An average 6-horsepower engine will do good work in operating a hay baler. If a machine is purchased with the motor power mounted on the frame, it should be investigated to see if the gas engine can be removed to be used at other jobs when not required to run the hay press. All power presses compress

the hay by the use of a pitman and plunger head. The power from the engine to the press is usually transmitted by a belt.

450. Self-feeder.—All power presses are provided with self-feeding devices. These are operated mechanically and are so timed that when the plunger is retarded, the feeder is forcing the hay down into the baling chamber. As the plunger comes back, the feeder is raised up out of the way and remains up long enough for a fresh supply of hay to be pitched into the hopper. The speed of the engine and the gearing will determine the number of strokes per minute. Most presses should operate with some 17 to 28 strokes per minute. All presses should have a tucking device to fold over the tails and allow them to be pressed into the bale by the next stroke of the plunger.

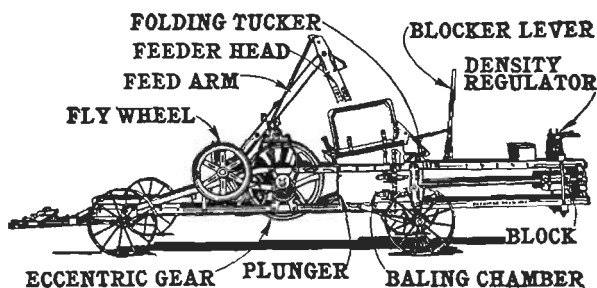


FIG. 415.—Power hay press.

451. Block Setter.—Many presses are now equipped with a special block-setting device so that it is not necessary for the operator to risk his fingers or his hand in placing the block (Fig. 415).

The block is placed in a special container and when it is desired that a new block be set, this container is brought forward by a lever and the feeding device, on its downward stroke, strikes the block on top, shoving it automatically into place. Other presses may have a special retainer which is tripped by pressing a button, thus setting the block automatically.

All feeder heads should be equipped with safety devices to prevent breaking the feeder arms in case the feeder head should catch on an obstruction on its downward stroke. Some have an automatic release clutch; others have large springs to allow the feeder arms to give without breaking them.

452. Press Sizes.—The size of the press is given according to the size of bale made. The more common sizes are: 14 by 18 inches, 16 by 18 inches, and 18 by 22 inches. The average length of the bale is around 36 inches.

453. Capacity of a Press.—In considering the capacity of a hay press of any kind, it is well to consider things, other than that of the press itself, such as (1) the kind of hay, (2) condition of the hay, (3) the number

of strokes at which the press runs, (4) the experience and ability of the crew, (5) density of bales desired, (6) the number of resettings that will have to be made, and (7) the size of the bale. All of these things considered collectively will determine to a certain extent the number of bales or tonnage a press may put out in a day's time.

454. Density of Bales.—The density of the bales is regulated by closing the outlet to such an extent that it will be harder for the compressed hay to be forced out. Naturally, the greater the force required to move the hay out of the baling chamber, the greater the density will be, and the more pounds per cubic foot.

455. Windrow Pick-up Hay Baler.—The pick-up baler is a regular power hay baler with a pick-up and cross-conveyor feeder attachment (Fig. 416). The pick-up attachment is a modification of the windrow



FIG. 416.—Windrow pick-up hay baler operated by auxiliary gas engine mounted on the press.

pick-up attachment for combine harvester threshers. The hay pick-up consists of a pick-up cylinder, an elevating unit of either canvas or lugged chains, and a cross-conveyor to receive the hay from the elevator and carry it to the self-feeder. The tight-bottom elevator prevents the loss of tender leaves.

Power for operating the baler or press and cross-conveyor is furnished either by the power take-off tractor (Fig. 417) or by an engine mounted on the press (Fig. 416). The pick-up and elevating unit is ground driven so that the hay is gathered in at the same rate of speed as the forward travel of the machine.

The cross-conveyor is operated as a unit with the press, independent of the elevator, and can be started, stopped, or reversed by a lever that can be kicked over with the foot or operated by hand. Thus, the cross-conveyor can be stopped to drop in the division blocks, and the machine can be used as a stationary baler without operating the pick-up cylinder and elevator.

A crew of from two to four men, depending on the yield of hay, is required to operate a pick-up baler. One man drives the tractor, two men tie out the bales, and in heavy hay one man assists the feeding mechanism. A crew of this size can average baling two to three tons per hour, the

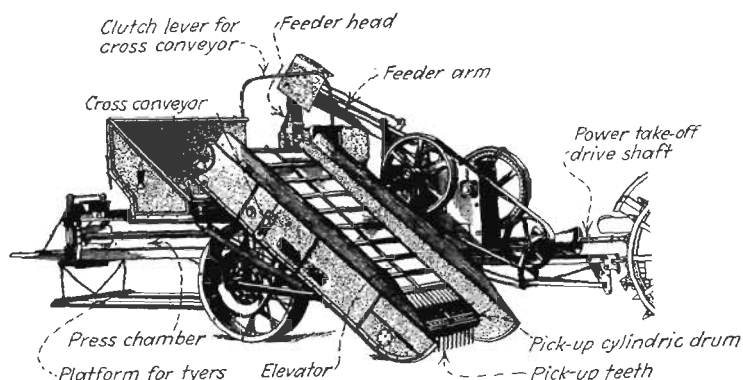


FIG. 417.—Windrow pick-up hay baler operated by power take-off of tractor.

tonnage baled fluctuating with the yield. The capacity of the machine largely depends upon two factors; namely, (1) a windrow large enough to furnish hay for capacity operation and (2) the skill of the operators.¹

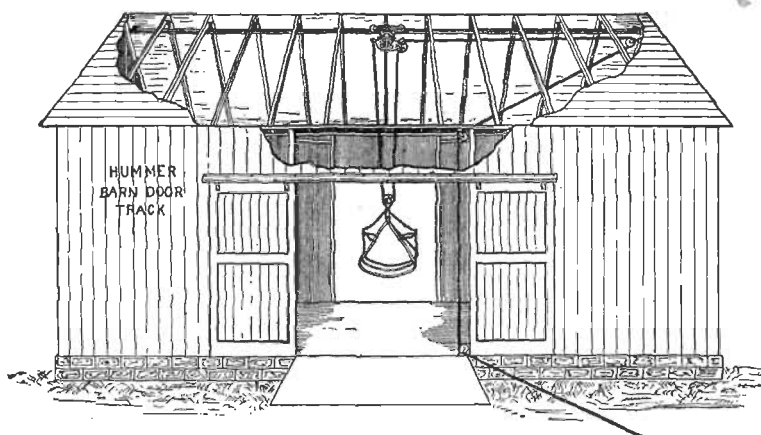


FIG. 418.—Arrangement for unloading hay at center of barn with grapple fork.

Figuring labor, tractor charge, and depreciation the estimated cost of baling hay with the windrow pick-up baler averaged \$3.45 per hour. When baling 1.59 tons per hour the cost per ton was \$2.17, but when 2.75 tons were baled per hour the cost was reduced to \$1.42 per ton.

¹ Iowa Agr. Expt. Sta. Bull. 322, p. 206, 1934.

BARN EQUIPMENT

Where loose hay is stored in barns, special equipment for handling it is of great help. There should be a track suspended at the peak of the roof as near the rafters as possible. A carrier truck runs along this

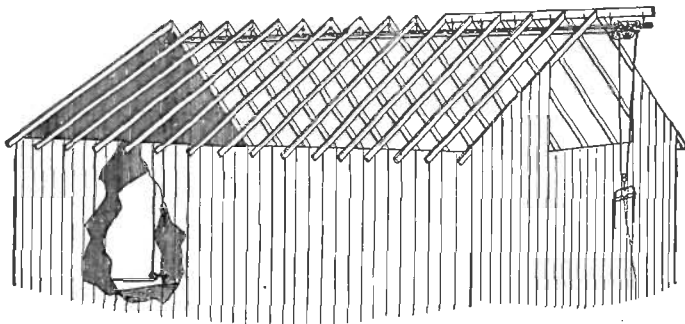


FIG. 419.—Arrangement for unloading hay at end of barn with double-harpoon fork.



FIG. 420.
Single-har-
poon hay-
fork.

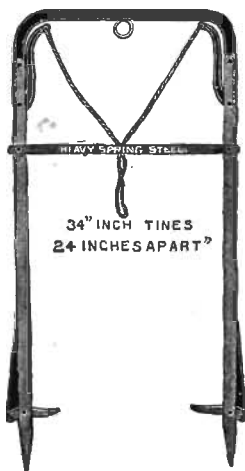


FIG. 421.—Double-har-
poon fork.

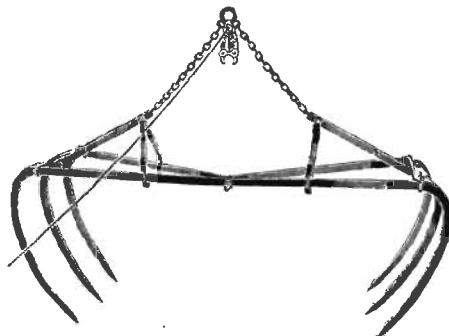


FIG. 422.—Six-tine grapple fork, open.

track to allow the hay to be carried to any part through the center of the barn. Figure 418 shows an arrangement for unloading hay at the middle of the barn while Fig. 419 shows an arrangement for taking the hay in at one end. The hay is elevated by a system of ropes and pulleys. Usually a team of horses furnishes the power for lifting the load.

456. Hayforks.—The types of hayforks and slings, for unloading hay from the wagon to place it on the stack or in the barn, differ in the manner in which they take hold of the hay. There are usually three kinds of forks; namely, the single-harpoon, the double-harpoon, and the grapple fork.

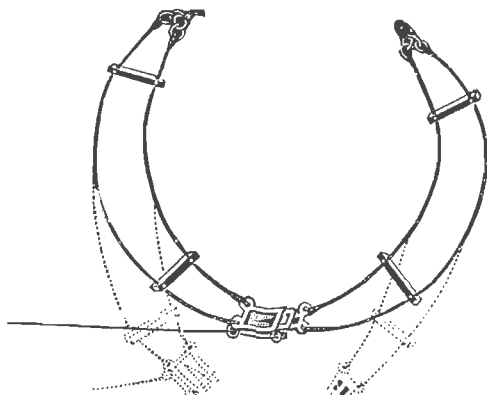


FIG. 423.—Center-trip hay sling.

The *single-harpoon* fork (Fig. 420) consists of a single long iron fork with a barb on the end, which, when the bar is being forced into the hay, forms part of the point, making it easier to force the fork down. When it has been forced to the required depth, a lever arrangement pulls this barb to the side, causing a considerable amount of hay to cling to the fork which can be elevated to the stack or carried inside the barn.

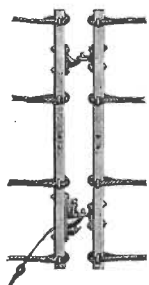


FIG. 424.—Double lock for hay sling.

Double-harpoon forks, instead of having one spear-like prong, have two prongs placed some two feet apart (Fig. 421). This type of fork is more popular than the single harpoon because it will retain more hay upon it.

The *grapple* fork (Fig. 422) resembles, in a general way, a pair of ice tongs. There are two or three teeth to each side which open out when forced into the hay and, as power is applied to the central point, they act in a manner similar to that of jaws, clamping a considerable amount of hay in the teeth. This is a very useful type in unloading loose straw or grain.

Another device for taking the hay from the wagon is the *sling* (Fig. 423). In the loading of the hay on the wagon rack, the first sling is placed on the bottom, a quantity of hay placed on it, as much as can be elevated at one time, then, another sling is placed on top of this hay, and so on until the wagon is completely loaded. Then, at the barn the ends of these slings are brought together and elevated into the barn or on the stack. When it is ready to be dropped, the sling is tripped in the middle, allowing the ends to swing free.

CHAPTER XXIII

GRAIN HARVESTING MACHINERY

GRAIN BINDERS

The grain binder must be built comparatively light, but strong so that it can be drawn over soft mellow soils without affecting the operation of the machine. The average grain binder with all attachments and the weight of the operator added will usually weigh around 1,500 to 2,000 pounds.

There is very little difference in the binders made by the various manufacturing concerns; however, they may be classified as horse-drawn and tractor-power take-off types. The size of a binder is determined by the width of the swath it will cut. Horse-drawn binders range from 6 to 8 feet, while tractor binders usually cut a 10-foot swath.

457. Main Wheel.—The grain binder is supported at three different points; namely, by the main wheel, the grain wheel, and, if drawn by

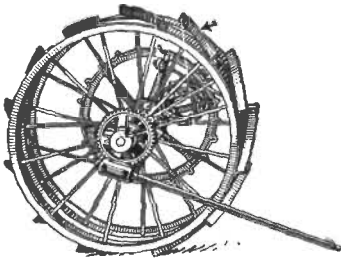


FIG. 425.—Binder main wheel showing lugs, driving sprocket and raising mechanism.

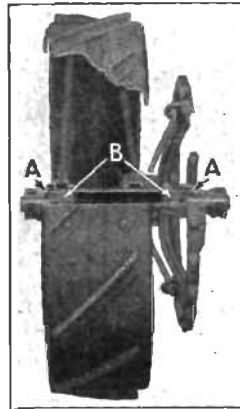


FIG. 426.—Main wheel showing roller bearings at B, and ball-thrust bearings at A.

horses, the tongue truck in front; if tractor drawn, the weight in front is supported by the tractor. Of these three points, the main wheel must carry fully 80 per cent of the entire weight of the machine. A wheel when required to carry a load ranging from 1,500 to 2,000 pounds must necessarily be built very strong. The main wheel (Fig. 425) is built entirely of steel; the rim or tire is rolled from one piece of steel with the ends welded together. The edges of the tire are turned inward to

further strengthen it. Spokes are riveted to both the hub and the tire. The tire end has a shoulder resting against the inner side of the tire. The lugs are placed at an angle across the tire and set rather high to give the proper amount of traction necessary to furnish power to operate the binder in the heaviest grain.

In each end of the hub of the main wheel are placed two long roller bearings to take care of the radial load and just outside of each of these are ball bearings to take care of end thrust (Fig. 426). No matter which way the thrust may be, it comes in contact with a rolling surface, reducing the friction to a minimum.

Located on the end of a shaft extending through the hub are two small spur gears which fit into a gear quadrant on the frame to allow the binder

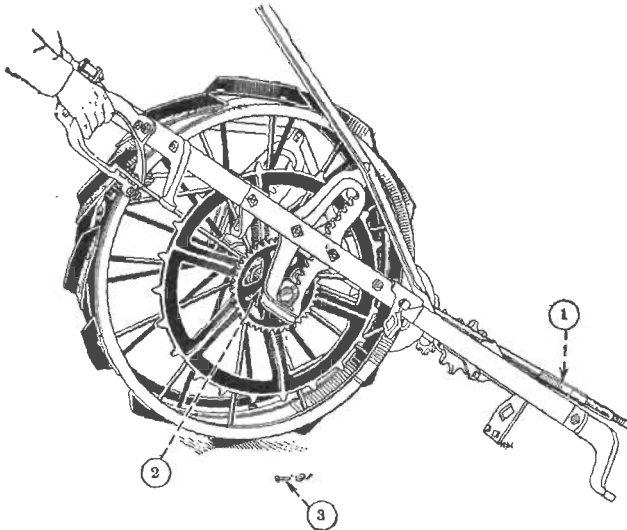


FIG. 427.—Main wheel being placed in main frame.

to be raised or lowered upon the wheel. On the left side of the wheel is attached a driving sprocket which is reinforced by radial rods extending from the rim of the wheel to a point well out on the sprocket (Fig. 425).

458. Frame.—Built around the main wheel is a rigid frame (Fig. 427) to which are attached the other working parts of the binder. This frame must be built of light but of strong steel which may be of the flat-bar or angle-bar type, the whole being well braced to assure rigidity and to prevent the various shafts from getting out of alignment.

459. Countershaft.—The countershaft is placed on the frame to the rear of the main wheel and parallel to the axle (Fig. 428). Located upon the countershaft are the bevel gear, clutch, sprocket, and a means for adjusting wear on the bevel gear. There are roller bearings on both ends of the shaft and on the end opposite that having the bevel gear is

a ball-thrust bearing against which pressure is constantly maintained by means of a setscrew. The bevel gears are held firmly against the bevel-pinion gear on the crank shaft, and run in an enclosed oil bath (Fig. 428).

The clutch consists of a hub-like arrangement which has been cut in an irregular line somewhat on the order of ordinary hand saw teeth so that when they are fitting together, both turn as a unit (Fig. 429). The sprocket end of this clutch is free on the shaft and only when it is in contact with the teeth of the outer end, which is keyed to the shaft, does it transmit power to the binder parts.

Passing around the sprocket is a large drive chain which receives power from the sprocket on the main wheel. This chain may consist of either a pintle or a hook type of malleable-iron or steel construction. An idler is placed on the under side to adjust the tightness of the chain.

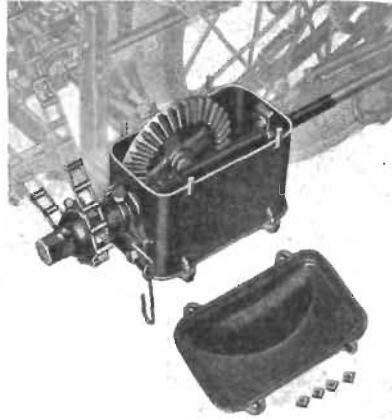


FIG. 428.—Enclosed gear case and oil bath for bevel gears on the countershaft and crank shaft of grain binder.

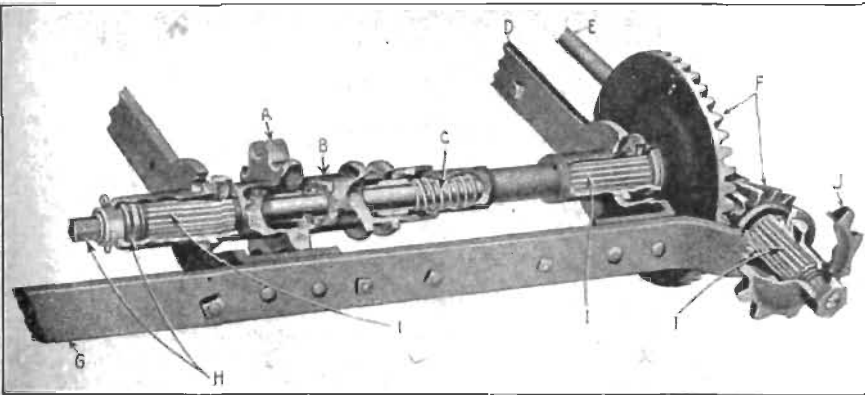


FIG. 429.—Binder countershaft and crank shaft: A, drive sprocket; B, clutch; C, clutch spring; D, frame; E, crank shaft; F, bevel gears; G, frame; H, adjustable end-thrust ball bearing to keep gear and crank-shaft pinion always in mesh and to take up wear; I, roller bearings; J, drive sprocket for platform, elevators, and binder attachments.

460. The Crank Shaft.—The crank shaft is located along the right side of the main wheel and at right angles to the countershaft (Fig. 430). It extends from the rear of the machine to the front and transmits the power delivered by the countershaft to the pitman.

At the rear and on the outer side of the bevel-pinion gear is placed a sprocket which furnishes power to drive the various elevators, platform canvas, reels, and binder head. On some binders, however, an extra sprocket is placed near the front for operating the binder head only.

The front end of the crank shaft is sometimes fashioned into a crank for the attaching of the pitman and in other cases it has a pitman wheel. But unlike the pitman wheel of the mower, it is not made heavy or counterbalanced.

The crank shaft has a roller bearing at the rear and a solid bearing in front. The reason a roller bearing is not used at the front end is because the reciprocating action of the pitman is too hard upon a bearing of this type unless it be exceptionally well designed. Practically all binder

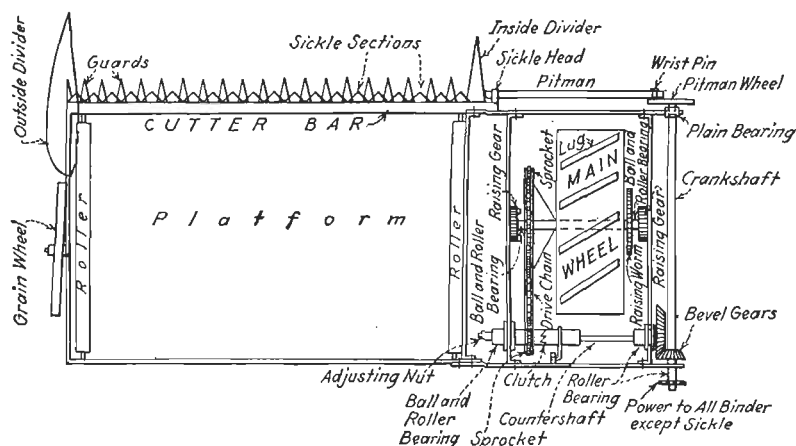


FIG. 430.—Overhead view of the transmission of power from main wheel to sickle, with frame and platform.

pitmans are made of wood. There are no metal straps placed on the side as on the mowing-machine pitman. Holes are bored through the wood so that the pitman can be slipped on the wrist pin of the pitman wheel or crank shaft and upon the sickle head. The pitman is prevented from getting out of place by special fasteners at each end.

461. Sickle.—The sickle for grain binders compares very closely with the knives for mowing machines; the principal difference is that the sections of the sickle are smaller and serrated along the edges. The sickle, instead of passing from the center of one guard to the center of the other, passes from the center of one guard directly through the next and on to the center of the third. The travel is twice the distance of that of the mowing-machine knife and the speed, of course, is about one-half as great. Since the binder is cutting only the stems of small grains, not so much power and speed are required as in the mowing machine which must cut hard grass stems closely matted together.

462. Guards.—Guards on the binder are very much smaller than those on the mowing machine. They are attached directly to the cutter bar (Fig. 431) which is nothing more than the front framework of the platform. Provision is made for keeping them in proper alignment in practically the same manner as that of the mowing-machine guard.

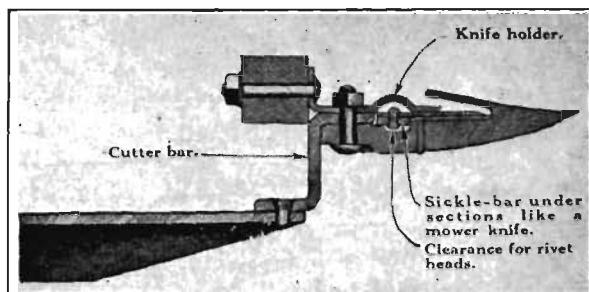


FIG. 431.—Cross-section of binder-cutting mechanism.

463. Ledger Plates.—Since the sections of the sickle are serrated, the ledger plate edges are smooth. Exclusive of the size, this is practically the only difference between ledger plates for grain binders and those for mowing machines.

464. Sickle Clips.—The clips for holding the sickle down are essentially the same as those found on mowing machines.

465. Reel.—Just before the sickle cuts off the stems of the grain, the reel which is located just above the cutting mechanism should strike

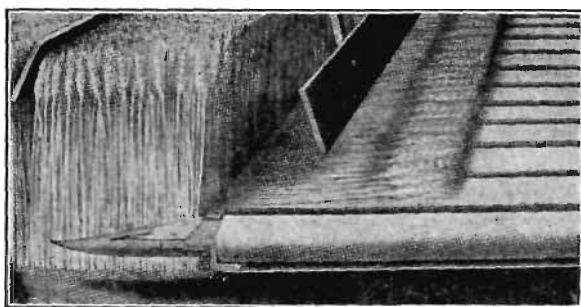


FIG. 432.—Action of reel in cutting short grain.

the heads of the grain some 3 to 6 inches from the top of the heads (Fig. 432). The reel slats should come in contact with the grain slightly before the stems have been cut off by the sickle, so that the grain will be lifted and thrown back on the platform canvas. Generally, the outer end of the reel should be slightly higher and set farther forward than the inner end. This is to retard the heads of the grain as much as possible.

The reel is adjustable both vertically and horizontally. If tall grain is being cut, it is necessary that the reel be elevated until the slats strike below the tips of the heads; the same is true if low grain is being cut. In some cases the grain may be so dwarfed that it is dangerous to lower the reel to the point where the grain will be delivered to the platform canvas. It is necessary in such cases to tack strips of heavy ducking canvas to the slat so that the grain will be forced back out of the way of the cutting mechanism on to the platform canvas.

The power for running the reel is transmitted from the crank shaft to the upper roller of the lower elevator, through the roller, to the opposite side and then to the reel by any one of the four following ways: by gear, by chain, by chain and gear, or by knuckle joints.

466. Grain Wheel.—Located on the outer end of the platform is the grain wheel which supports part of the weight of the binder (Fig. 430). This wheel does not run directly forward as does an ordinary type of wheel; instead, it sits at an angle slightly under the end of the platform with the front side angling inward. It is also placed on the inside of the divider point which prevents the uncut grain from being mashed down. The angle at which the wheel runs prevents, to some extent, side draft.

467. Platform.—The platform (Fig. 430) consists of a framework of steel provided with a sheet-steel bottom which acts as a protection to

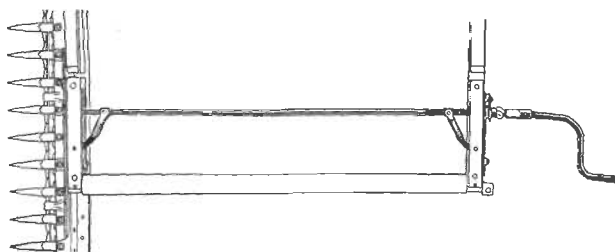


FIG. 433.—Platform canvas tightener.

the platform canvas operating over two rollers, one of which is placed at each end of the platform frame. Suspended above the rear part of the platform is a back curtain to prevent the wind from interfering with the grain falling on the platform canvas.

On each end and extending quite a distance to the front are the grain dividers which divide the grain and guide it into the cutting mechanism. (Fig. 430.) In order to go through gates, each of these dividers should be made to fold up over the platform out of the way. The power for operating the platform canvas is taken from the rear of the countershaft and transmitted to the front canvas roller by a chain. The top of the canvas moves inward so that any grain that falls upon it will be delivered to the elevator canvases which are located at the inner end.

Figure 433 shows a means for tightening the canvas or relieving the tension, as may be necessary. The tension of this canvas should be

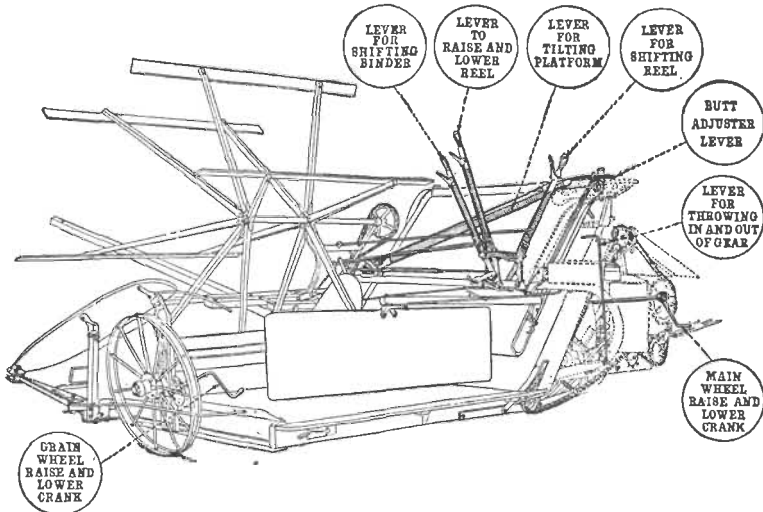


FIG. 434.—Position and function of levers of an ordinary grain binder.

tight enough so that there will be no danger of it slipping upon the rollers. A too tight canvas will cause excessive wear on the rollers and on the canvas itself.

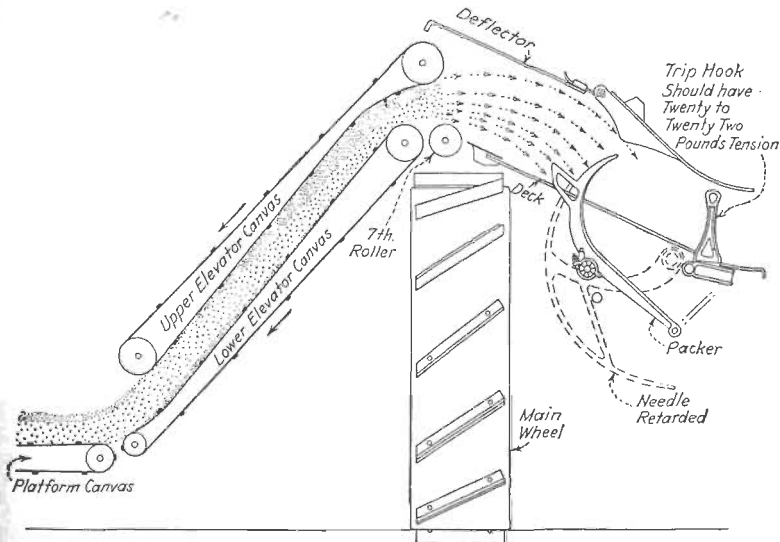


FIG. 435.—Illustrating how the grain is carried from the platform to the deck.

468. Elevators.—There are two elevator canvases: the upper and the lower (Fig. 435). Each of these canvases travels in opposite direction

over a set of two rollers. It is essential that the rollers be square with each other for the canvases to run true. Figure 436 shows how to test the elevator frame for squareness. The insides of the canvases are made

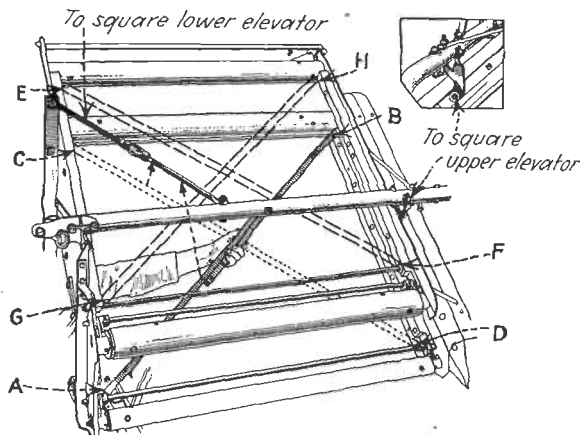


FIG. 436.—Method of testing and squaring up both the lower and upper elevators.

to travel in the same direction so that the grain, when delivered by the platform canvas to the lower elevator canvas, is aided by the upper elevator canvas which holds the grain between them and carries it up to the top, delivering it to the deck.

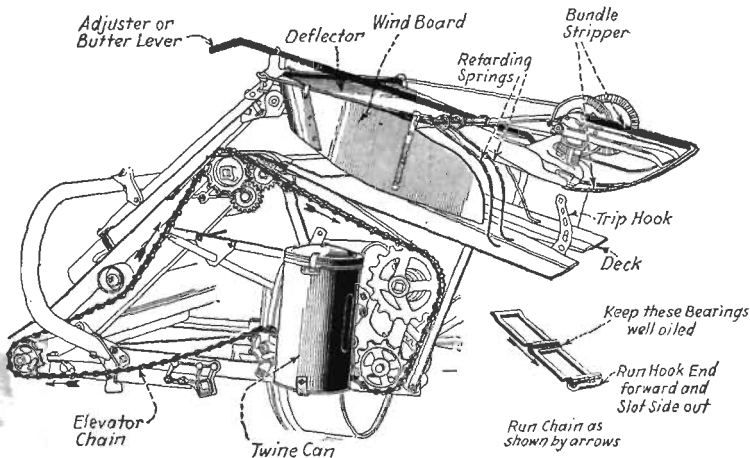


FIG. 437.—Elevator chain, deflector, adjuster lever, and bundle stripper.

The power for driving the canvases is taken from the rear end of the crank shaft and is transmitted by means of the same chain that operates the platform canvas (Fig. 437). This chain operates over a sprocket of the upper roller of the lower elevator canvas and the power is carried

through to the opposite end where a set of four spur gears are located, causing a reversal of the motion to the upper roller of the upper elevator.

Some manufacturers make the upper elevator adjustable, or to float so that it will adjust itself for heavy or light grain.

Each elevator should have special canvas tighteners to relieve the tension when the binder is left idle over night (Fig. 438).

469. Seventh Roller.—The seventh roller (Fig. 435) is located between the upper roller of the lower elevator and the deck. It is an extra roller which has no canvas stretched over it. The top surface rotates toward the deck. The function of this roller is to carry the grain over from the elevator to the deck, preventing the lower elevator canvas from dragging some of the grain down on the drive chain. The roller is driven by the upper roller of the lower elevator. An intermediate gear is used to give the same direction of rotation for the seventh roller.

470. Deck.—After the grain has been delivered by the elevator and passed over the seventh roller, it is deposited on the deck (Fig. 439)

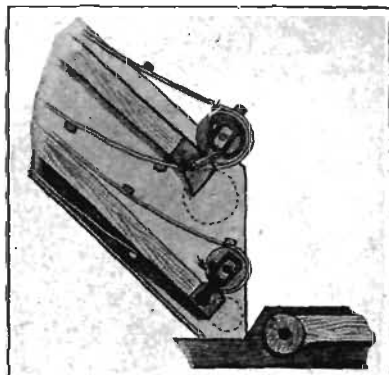


FIG. 438.—A simple method of loosening elevator canvases. The lower rollers are pulled up.

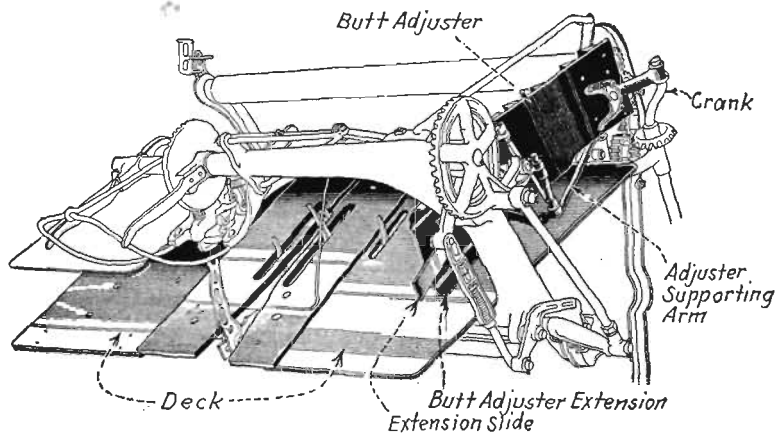


FIG. 439.—Binder deck.

down which the grain slides. Decks are made of either steel or wood, both being extensively used. Some binders are made with a deck having quite a steep slope, while others are made comparatively flat. The steep deck is better because the grain will slide down to the packers much easier than where the deck is flat; it also helps to prevent choking

under the shield. Where the steep deck is used, it is necessary that the grain be elevated higher and requires more work of the elevators to accomplish the task.

471. Butt Adjuster.—The butt adjuster, often called the *butter*, is driven from the front of the upper roller of the lower elevator or from the front of the seventh roller. The purpose of the butt adjuster is to even up the butts of the grain and assist the grain down the deck to the packers. A lever controls the position of the butter. It should run as far forward as possible. There are two types of butt adjusters: the vibrator and the endless belt. The vibrator type (Fig. 439) is driven by a crank from either of the two places mentioned and causes the butter board to work back and forth, evening up the grain and, at the same time, having a slight downward movement to shove the grain on down the deck. The endless-belt type may be either of canvas or of steel and operates over two rollers in very much the same manner as that of a canvas. Of the two types, the vibrator type is used more extensively.

472. Binder Attachment.—The function of the binder attachment as shown in Fig. 440, is to tie the grain into bundles after it has been

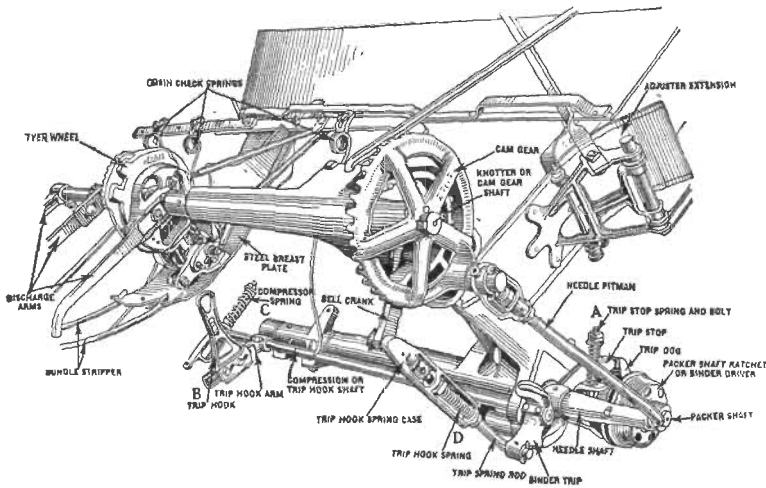


FIG. 440.—Binder attachment.

cut and elevated by the harvesting part of the binder. This attachment works independently of all the other parts; it, however, must be in proper correlation with them. It can be removed without affecting the operating of the cutting and elevating of the grain.

There are two ways of furnishing the power to binder heads. One way may be the chain, operating over a sprocket on the rear end of the packer shaft, that operates the platform canvas and elevators; the other may be an independent sprocket on the crank shaft, over which operates

a chain passed around a sprocket near the front end of the packer shaft. From the packer shaft the power is distributed to the tying apparatus, including the knotter head, needle, and tier shaft. The complete binder attachment includes all parts that have to do with the tying and forming

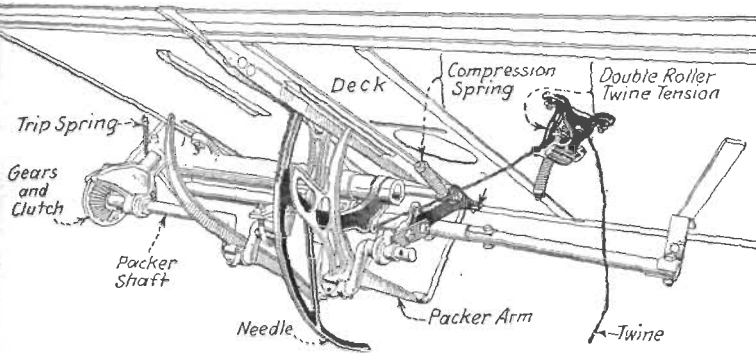


FIG. 441.—Under side of binder deck showing various parts.

of the bundle, and are the packers, needle, knotter, knotter shaft, and the discharge arms.

The binder attachment can be shifted forward and backward to regulate the position of the band on the bundles, which should be as near the center as possible.

473. Packer Arms.—The packer arms are operated from a packer shaft (Fig. 441) which is sometimes known as a *crank shaft* because the

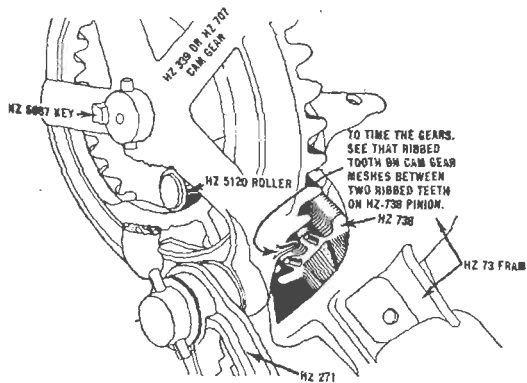


FIG. 442.—The gears for driving the binder attachment are marked.

crank throws are somewhat like those on the crank shaft of the ordinary gas engine. These cranks cause the packers to revolve upward and downward above the top of the deck. The grain is pulled and forced down with the packer arms which pack it into a compact mass, against the trip hooks, ready for the needle to pass the twine around it and the

knotter to tie the knot. On some binders there are more packer arms than on others. In the majority of cases there are only two packer arms working alternately, while on others a third packer is used.

Figure 442 shows how the gear teeth are marked so that if the binder attachment gets out of time or new parts are to be installed, it can be easily retimed.

474. Other Parts of the Binder Head.—The trip hook (Fig. 440) should be set at about medium. At the time the bundle is tied, the needle (Fig. 441) comes over from the top while the trip hook is exerting force from the bottom. The needle is operated by the needle pitman (Fig. 440) which is connected to the needle shaft at the front end. The pitman can be adjusted in length so that the needle can be made to travel far enough forward to make sure that the twine is delivered to the twine-holder disk.

475. Knotter.—Of all the parts involved in the binder attachment, or the whole binder for that matter, the *knotter head* (Figs. 443 and 444),

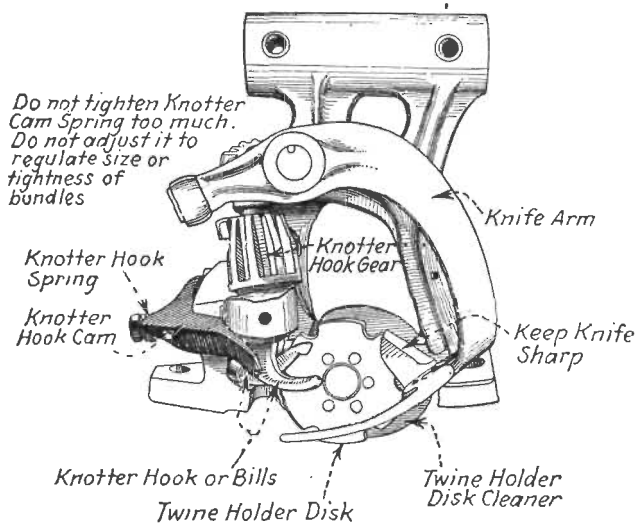


FIG. 443.—Knotter head showing bill hooks and bill-hook spring, twine holder, and knife arm.

or the parts that tie the knot, is the most delicate and complicated. More trouble is often given by this one small piece of mechanism than is encountered by the rest of the whole machine. It consists of a cam gear wheel which has two sets of gear teeth for operating both the twine-holder disk and the bill hooks. There are a twine-holder-disk spring, a bill-hook spring, a knife for cutting the twine, and sometimes a stripper arm to aid in stripping the knot from the bill hooks. All of these parts must be operated in correlation. If one part fails to work, it affects all

the others. The knotter heads on the various machines are not all the same, in regard to the details and constructions, but every one works upon the same general plan so that a thorough understanding of one or two different heads will enable any one to grasp the details of whatever type is met.

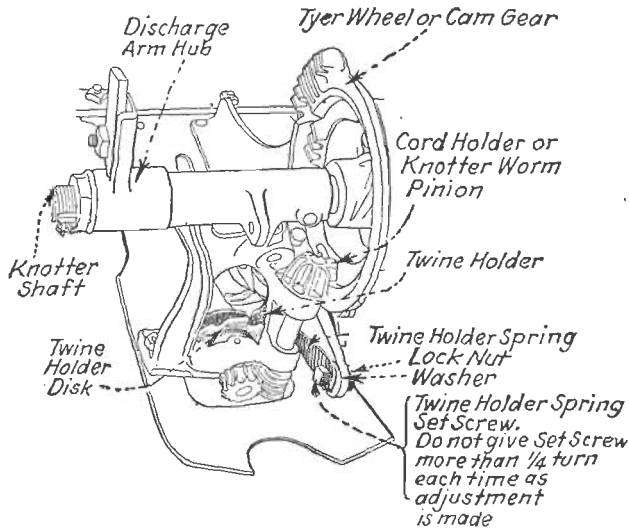


FIG. 444.—Knotter head showing twine disk holder and spring.

476. Knotter Types.—In general, there are two different types of knots tied by knotters; one ties a straight knot, while the other ties a bowknot. The types shown in Figs. 443 and 444 tie a straight knot. The type shown in Fig. 445 ties a bowknot. Some operators prefer the

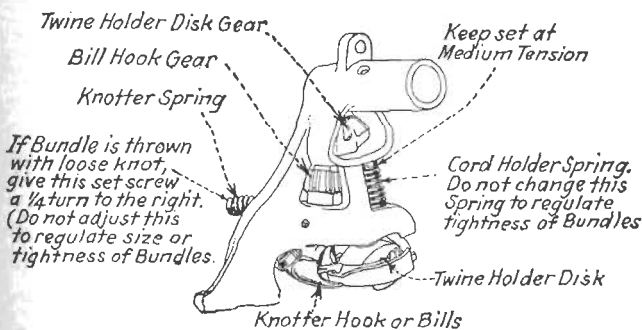
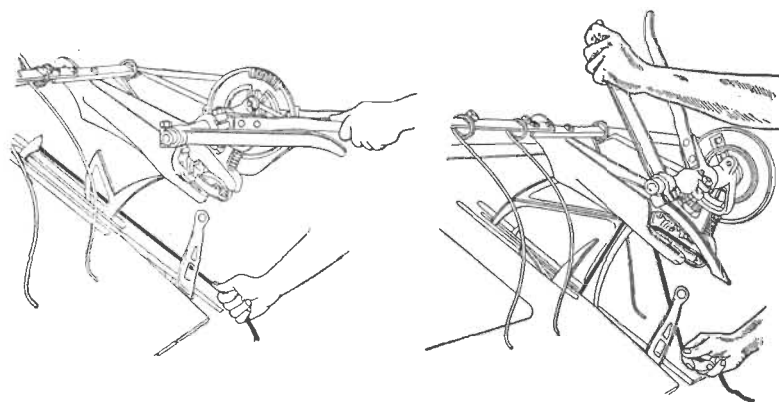


FIG. 445.—Knotter that ties a bow knot.

straight knot, arguing that a less amount of twine is used than for a bowknot. When a straight knot is tied, a small piece of twine is cut off and thrown away, while when a bowknot is tied, the amount of twine that would have been thrown away is included in the bow. There

is really no material difference in the amount of twine used by the different types of knotters.

477. Tying the Knot.—The needle brings the twine over the bundle of straw, placing it in the twine-holder disk which holds it securely while the bill hooks revolve, wrapping the twine around the bills, catching the ends of the band between them and holding it while the twine is pulled from over and around the bill hook, tying the knot. As the knot is tied and the cord cut, the twine-holder disk retains the end of the twine for tying another knot. The tension with which the twine disk should hold the twine differs somewhat with different types of twine disks, but, on the average, it will vary from 30 to 50 pounds as measured by an ordinary pair of hand scales. The cam gear is revolved on what



Starting position.

Needle turned part way over.

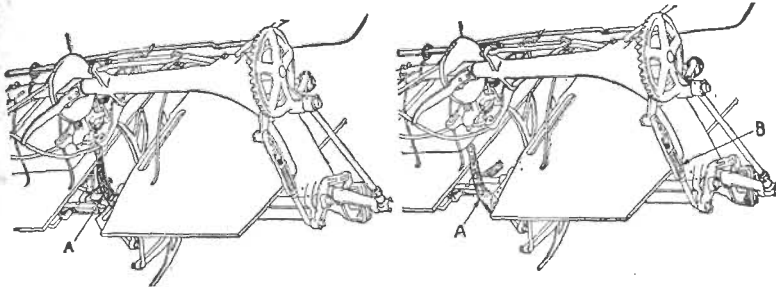
FIG. 446.—Illustrations showing correct position to hold twine to get it attached to twine disk.

is known as the *knotter shaft* upon which are placed the discharge arms. These arms are so placed that just at the time the knot is completed they come in contact with the bundle, forcing it out and discharging it onto the bundle carrier. The operation of the discharge arms also aids in finishing and completing the knot. In some types of knotters, the stripping of the knot from the bill hooks is done entirely by the discharge arms, forcing the bundle out. In others, they only aid the stripper arm in stripping the completed knot from the bill hooks.

The knife for cutting the twine for each band may be attached to either the stripper arm or held stationary against the twine disk. When the knot has been completed, the needle drops below the deck and the discharge arms and the other parts of the knotter head are locked to prevent turning until the proper amount of grain has been brought down for another bundle.

478. Twine Tensions.—To give the twine the proper amount of tension, a special apparatus called the *twine tension* is used. There are

three kinds: single-roller, double-roller (Fig. 441) and spring. In each of these types, the tension is regulated by a spring, held by a bolt. When the nut of the bolt is turned down, the twine is pinched together, causing it to pull much harder. The amount of tension should be 6 to 8 pounds.



To make small bundles, move trip arm *A* up as needed.

To make large bundles, move trip arm *A* down as needed. Tightening trip spring *B* makes tighter bundles.

FIG. 447.—To regulate the size and tightness of bundles make adjustments indicated.

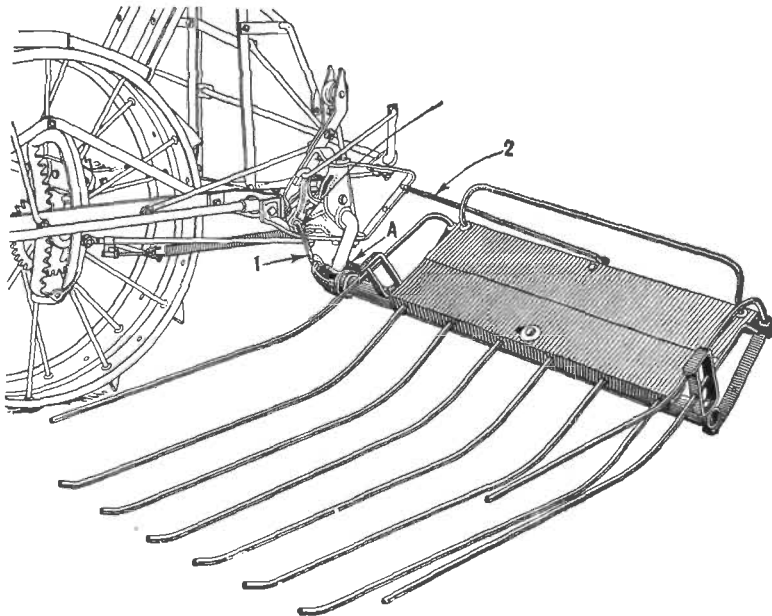


FIG. 448.—Bundle carrier.

479. Size and Tightness of Bundles.—As a general rule, the size of the bundles is regulated by moving the trip hook in or out on the trip-hook arm, and by tightening and loosening the trip spring. However, when the trip spring is adjusted, it will also influence the tightness of the bundles. Figure 447 illustrates these adjustments.

480. The Bundle Carrier.—When the bundles are discharged from the binding attachment, they fall upon the bundle carrier where the bundles remain until enough have been collected to fill it, then they are dumped. There are three types of bundle carriers:

1. Those that have the fingers of the carrier held at right angles to the direction of travel and discharge the bundles by folding backward and downward.
2. Another is where the fingers are placed parallel to the direction of travel and it dumps the bundles by dropping to the ground and letting the bundles slide off (Fig. 448).
3. The third type consists of nothing more than an endless canvas apron operating on two rollers. The bundles are collected until the operator throws it in action. They are then rolled to the side and the carrier is ready to receive other bundles. This carrier can be folded up out of the way, for transporting.

The first of these two types is sometimes rather hard to hold in position, especially if the stubble is high or obstructions are encountered. It also must be returned quickly after being dumped, to catch the first bundle. The second type is likely to scatter bundles, especially going up hill.

481. Tongue Truck.—All binders that are to be drawn with horses should be equipped with a tongue truck similar to that shown in Fig. 449.

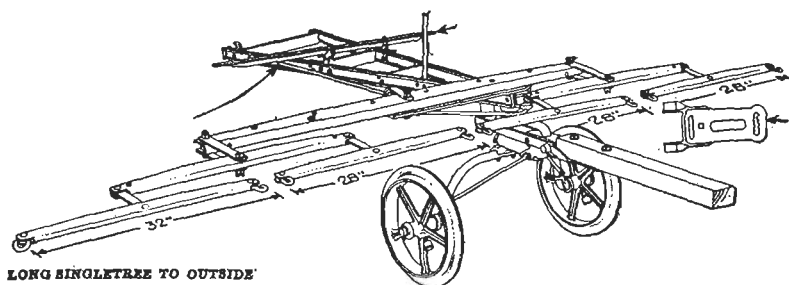


FIG. 449.—Tongue truck.

A truck will take all the weight off the horses' necks and eliminate whipping of the tongue. When a truck is used, the binder can be turned much better by the use of the quick turned type which is said to turn even faster than the team. Better adjustment of the binder in its operation can be secured.

482. Transport Trucks.—When a binder is to be moved any distance from one field to another or along the road, the weight of the binder should be carried upon two trucks which are placed on the binder at each side, allowing the main wheel to be elevated (Fig. 450). Then, the tongue truck is placed under the outer end of the platform and the complete binder moved at right angles to the direction in which it travels while cutting grain. This will also enable it, when the reel and dividers are folded, to go through a comparatively narrow gate.

483. Binder Troubles.—When looking over a binder out of adjustment, get all the information possible about the machine. Do not hurry. See that the machine is properly put together, chain tight, pawl and needle properly timed and in good working order; examine the knotter head, tying one or two sample knots, turn the binder attachment by the discharge arms. Do not make any adjustments until the binder has been carefully examined, even though it is thought that the trouble has been located. Remember that the binder was made to work right and for every trouble there is a cause and, therefore, a specific remedy. Never make any adjustments to correct trouble until certain this is exactly what is required. If, as is often the case, after certain adjustments have been tried, they do not have the desired effect, put them

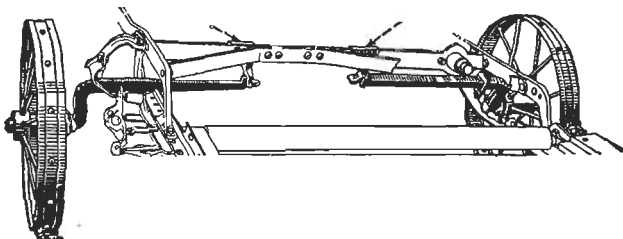


FIG. 450.—Transport trucks in place.

back as they were before making others. In inspecting a binder, it is necessary to reason from effect to cause. If this is properly done, the adjustments required to correct a trouble are usually few.

484. Chain and Gear Troubles.

1. *Chain:* Undue wear on the chains may be caused by their being too tight or backward.

Remedy: Loosen the tension or run the chain with the head of the links leading and slot outward.

2. *Oil:* The use of oil or grease in a sandy country will collect the fine particles of sand on the chain, causing it to wear very rapidly.

Remedy: Do not use oil or grease.

3. *Chains:* Chains sometimes will not stay on because the sprocket wheels are not in line. This may be caused from the boxes becoming worn, a wheel bent, or a bent shaft.

Remedy: Rebabbitt the boxes, get new sprocket wheel, or straighten the shaft.

4. *Gears:* Gears may act badly due to any of the following: gears being out of true, being out of line with each other, teeth meshing too tightly or not tightly enough, and the use of grease or oil in a sandy country.

Remedies: If the gears are not true, discard the old ones and put on new ones. If they are not in line, locate the cause and line up properly. If the teeth mesh improperly, remedy this by the mechanism provided for the purpose, if there is any, or look for wear on the boxes or shafts.

The gear wheels on a binder are seldom oiled or greased.

485. Canvas Troubles.

1. *Creeping*: The creeping of canvases may be caused by running them too loose or the elevators not being square.

Remedy: Square the elevators and see that the canvases are drawn tight. Have the tightness the same on both sides.

2. *Canvases not elevating the grain* may be caused by missing slats or loose canvases.

Remedy: Put on the missing slats and tighten the canvases.

3. *Broken slats* are generally caused by the elevators not being square or the canvases not being buckled evenly.

4. *Chewed slats* may be caused by a projecting bolt or the canvas guides being out of shape.

Remedy: Locate the cause of the trouble and remove.

5. *Slat binding*: Occasionally a slat or a number of slats are too long, causing binding.

Remedy: Saw off the slat or slats which are causing the trouble.

486. Binder-attachment Troubles.

1. *Pawl spring becomes weak*: As the pawl is the mechanical device by which the whole tying mechanism of the binder is put into motion, any trouble here will affect the whole, which makes a good basis on which to locate the pawl and pawl-spring troubles.

Pawl spring becomes weak, broken, or lost. This trouble may show itself in different ways. The pawl may fail to catch and the tying mechanism may not move at all when the trip is pressed. The pawl may catch momentarily and then let go, leaving the needle part away up and the discharge arm halfway around.

Remedy: Examine the pawl spring carefully and if weak, broken, or missing, supply a new one.

2. *Pawl failing to set*: Often the face of the pawl and ratchet become worn round so that instead of catching they slide past each other. This occasionally causes many small bundles.

Remedy: File the face of the pawl and ratchet until they meet each other squarely.

3. *Pawl and pawl rollers become worn*: The pawl and pawl rollers often become worn, especially when not oiled properly. This will result in the binder mechanism not being put in action. If one is not careful, he may mistake a worn pawl roller for a weak pawl spring, and *vice versa*.

Remedy: Replace the pawl rollers and put on a new pawl if necessary.

487. Needle Troubles.—On practically all binders, the needle should be completely advanced, just as, or a little before, the knotter bill comes parallel with knotter shaft.

1. *Needle slow*: Often as the mechanism which drives the needle becomes worn, it will not come up quick enough for the disk to catch the twine; thus it fails to tie a knot and the twine will not be caught in the disk as it did not get there soon enough.

Remedy: Shorten the needle pitman to bring it into time.

2. *Bent needle*: By continued use in heavy grain, the needle point may become slightly bent upward so that it does not bring the twine down into the twine disk and will act the same as a slow needle.

Remedy: The needle is the arc of a circle. Make a mark on the breast plate or deck where it comes through, and test. If bent up, take a gas pipe or something that you can grip well back on the needle and bend back again.

3. *Eye on needle worn:* The eye on the needle is made of especially hardened steel but sometimes it becomes worn so badly that the twine will not be delivered into the disk.

Remedy: Some machines have a small wheel that can be replaced. Otherwise, if the needle cannot be advanced enough to remedy the difficulty, a new needle must be put in.

488. Knotter-shaft Troubles.

1. *Slow discharge arms:* The discharge arms must come around soon enough to pull the twine from the knotter bill hooks. If the arms are slow, a perfect bundle will be tied and left with some twine hanging to the bill hooks.

Remedy: Advance the knotter-shaft gear wheel on cog. Then, time the needle properly.

2. *Discharge arms dropping down when set:* In some machines the mechanism which drives the discharge arms is locked in such a way as to prevent their dropping. In other machines, they are held up by a cam on the knotter-shaft gear wheel. If the lock should become weak or broken or the cam wheel worn, the arms will drop, causing the needle to raise.

Remedy: Tighten the spring which locks the arms up.

3. *Troubles due to pawl:* If the arms should fail to revolve, revolve part way and stop, or revolve continuously, the trouble is with the pawl.

Remedy: See Pawl Spring troubles.

4. *Throwing small bundles:* The throwing of small bundles may be caused by tangles—grain hanging on; a weak or broken spring; the faces of the pawl and pawl lock not being square with each other.

Remedy: If caused from heavy tangled grain, little can be done.

489. Knotter Head Troubles and Remedies.¹—The condition of the band is the best indicator of the source of trouble. *If the bundles are*

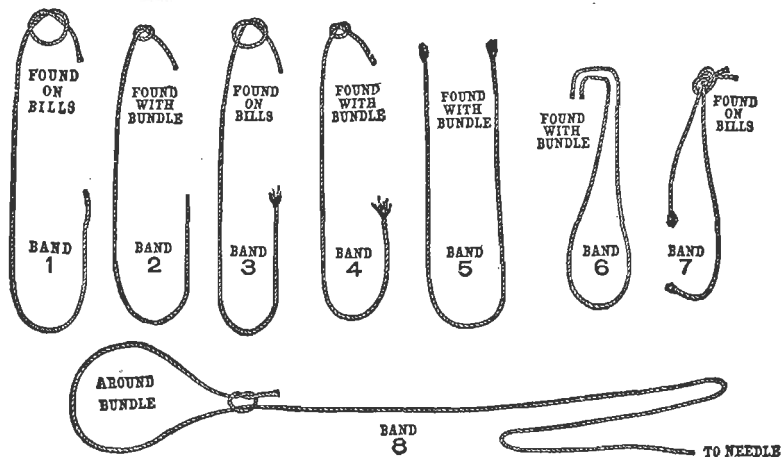


FIG. 451.—Condition of bands and where found as affected by the different knotter troubles.

not tied, examine the bands. The various types of bands shown in Fig. 451 show the condition of the band caused by different troubles.

¹ For more detailed explanation, see Ohio Ext. Ser. Bull, 87, p. 87, 1935.

FARM MACHINERY AND EQUIPMENT

Band 1 is found clinging to the bill hooks with a loose knot tied in it; the other end is cut smooth and square.

Cause: The twine-disk spring is too loose and the twine tension may also be too tight.

Remedy: Tighten twine-disk spring and loosen twine tension.

Band 2 is similar to band 1 except it is found with the bundle and the knot is drawn down fairly tight. The free end is cut smooth and square.

Cause: The twine-disk spring is too loose but the twine tension is in good condition.

Remedy: Tighten twine-disk spring but do not bother twine tension.

Band 3 is found on the bill hooks as in band 1 but the free end is crushed and frayed out.

Cause: Twine-disk spring too tight and the twine tension is also too tight—just the reverse of band 1.

Band 4 is found with the bundle with knot drawn close and free end crushed and frayed out.

Cause: The twine-disk spring is too tight. Nothing wrong with twine tension.

Remedy: Loosen twine-disk spring only.

Band 5 is found with the bundles with both ends of the band crushed and frayed out.

Cause: Twine-disk spring even tighter than in band 4. Twine tension perfect.

Remedy: Loosen disk spring gradually.

Band 6 is found with the bundles. Both ends show that they have been wrapped around the bill hooks to form the knot but not completed. They are bent and crinkled.

Cause: The bill-hooks spring may be too loose; or the *hump* on the under side of the upper bill may be worn away so the bills cannot hold the ends of the band securely enough when the knot is about to be completed.

Remedy: Tighten bill-hooks spring; replace bill hooks with new ones; a rat-tail file will aid in deepening the groove so the twine can be held better.

Band 7 is found on the bill hooks with knot completed but band broken at some other place.

Cause: Bill-hooks spring very tight, with loose bundles, or the stripper-arm cam is worn, preventing knots being stripped from hooks.

Remedy: Loosen bill-hooks spring; replace stripper-arm cam.

Band 8 is found with the slip noose tied around bundle with twine extending to eye of needle.

Cause: Eye of needle badly worn back and the needle cannot advance far enough to place twine in twine-holder disk.

Remedy: Renew roller in needle eye or put on new needle.

In attempting to make adjustments for any of the above troubles, make them gradually and one at a time. Turn the nuts or setscrews, as the case may be, only a quarter of a turn each time a change is made. If the trouble is not overcome, put all changes made back to their original positions. Then try something else.

490. Miscellaneous Troubles.

1. *New machine failing to start:* Occasionally a new machine fails to start, owing to some part sticking or catching.

Remedy: Test out for the trouble. Throw the binder out of gear and see that the bull wheel revolves without catching. Remove the elevator chain and throw in gear.

This will test the sickle. Next, put on the elevator chain and disconnect reel. This method will test one part at a time and should locate the trouble without difficulty.

2. *Hot boxes*: The heating or cutting out of boxes may be caused by boxes being too tight, improper alignment with the shaft, or lack of proper lubrication.

Remedy: If the box is solid, rebabbitt and see that it receives plenty of good lubricating oil. If a split box and it heats, put shims between the two halves and oil well. Of course, if any box is badly worn, line properly with shaft and rebabbitt.

3. *Badly shaped bundles*: Poor bundles in good grain are caused from improper manipulation of the binder.

Remedy: Reel the grain properly; retard the heads and keep the butt adjuster straight.

4. *Heavy draft*: Heavy draft may be caused from lack of sufficient good lubricating oil; bull wheel being centered in quadrant wrong; chains, especially main drive chain, being too tight; and paint or varnish not being cut out of the bearings.

Remedy: Apply lubricating oil to bearings. Center the bull wheel in the quadrant, square. Have the proper tension on the chains. Kerosene oil will cut the paint or varnish from the bearing surfaces.

5. *Side draft*: Side draft is usually caused by the grain wheel bearing being too tight or out of line. Long cutter bar.

Remedy: Arrange the bearing so that there is no undue friction and see that it runs straight.

6. *Horses*: A fast horse on the outside will sometimes make trouble with the draft of a binder.

Remedy: Put fast horse next to grain.

7. *Getting the grain from the elevator to packer*: Trouble is sometimes experienced in getting light fluffy grain to the packers.

Remedy: See that the 7th roller is working properly and lower the deck cover.

491. Auxiliary Power.—Where teams are used to draw the binder, much strain upon them may be eliminated by the use of a small gas engine mounted upon the frame of the binder and connecting with the mechanism by a chain extending from the engine over the sprocket of the crank shaft. Then, the power operates the sickle, platform, reel, elevators, and binding attachments instead of the main wheel. By this method, only two horses are necessary to haul the machine where formerly at least four horses were needed. The binder-operating mechanism is operated continuously and smoothly with fewer horses. An engine suitable for this type of work may be mounted upon the binder frame with very little trouble and furnish plenty of horsepower for the operation of all parts.

492. Binder-tractor Hitch.—With the large amount of motor power, in the form of tractors, available for the drawing of binders, some special type of hitch should be provided. There are many types of patent hitches for such work that allow one binder to be drawn by itself, or two or more can be hitched tandem and operated successfully with one tractor. A typical hitch is shown in Fig. 452. Some of these tractor hitches do not require any aid for steering, on the part of the operator of the binder. It is said that some hitches do not put an extra strain

upon the binder frame because of the way the hitch is connected. One type of hitch is made so that when the tractor makes a turn to the left at a corner, it swings the binder around with the main wheel acting as a pivot. This swings the tongue of the truck on the rear binder to the

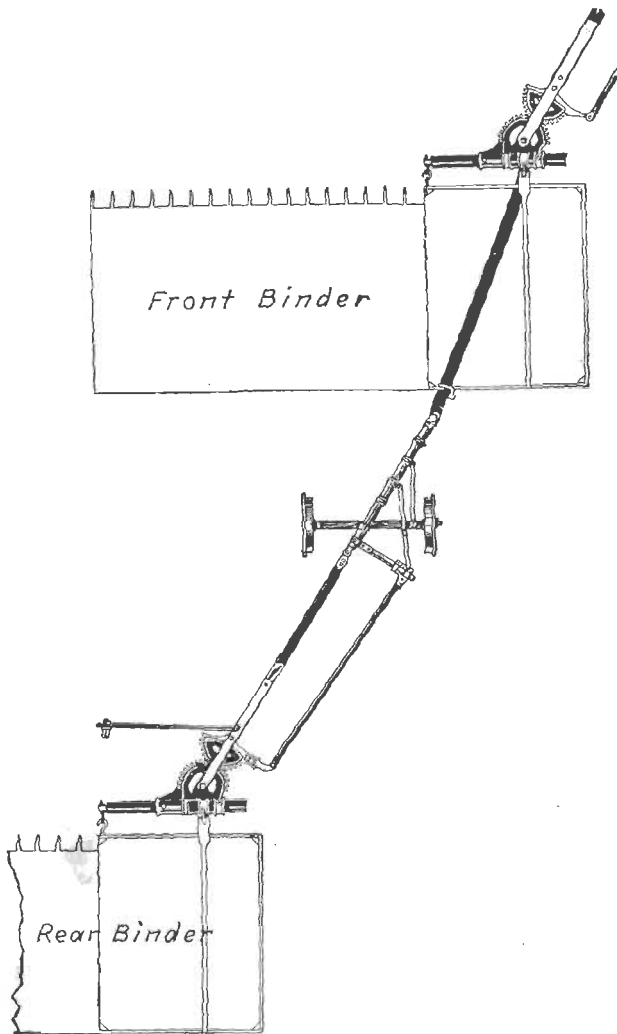


FIG. 452.—Automatic binder hitch.

right and thereby prevents the rear binder from turning into the standing grain. When the first binder has finished the turn, and moved forward a few feet, the action of the parts is reversed which throws the stub tongue of the following binder sharply to the left and steers the second binder around the turn just at the right time.

493. Tractor Binder.—Grain binders built in 9- and 10-foot sizes, especially to be operated with tractors, are available (Fig. 453). The binder mechanism is driven by power transmitted directly from tractor (Fig. 454) by a revolving shaft. The power take-off is controlled by the



FIG. 453.—Grain binder drawn by tractor and operated by power take-off

engine clutch and the belt pulley gear-shift lever on the tractor. This makes it possible to keep the binder cutting and binding mechanism operating while the binder and tractor are standing still. The power shaft is equipped with universal joints which make it possible to transmit the power when the machine is making a turn as well as to drive the mechanism when the binder is tilted in different positions. An adjustable snap clutch prevents breakage should the binder become clogged.

494. Rice Binders.—Binders built to harvest rice are similar to the regular grain binder, but since it is often required to operate on soft

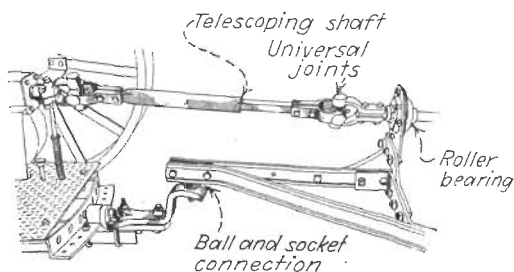


FIG. 454.—Hitch and drive shaft for power-take-off operated grain binder.

muddy ground, it must be designed for such conditions. The sides of the main wheel are entirely covered with galvanized sheet iron to exclude the mud (Fig. 455). The grain wheel is shielded in a similar manner on one side. Special spade lugs are provided to give suitable

traction. The metal parts that are exposed to the wet rice are galvanized, and the elevator is built higher. A large percentage of rice binders are now drawn by tractors and operated by power take-off.

495. Care of the Binder.—At the end of the cutting season special care should be given the binder before it is put away for the winter. Putting away should not mean that it is set out in the barnyard or left in some fence corner. The binder should be placed under a shed to protect it from weather conditions and to prevent decaying of the wooden parts and rusting of the metal parts. While the team is still hitched to the binder, all parts should be gone over thoroughly and all bearings and points of wear given a thorough soaking in oil. Then, the binder should be run for 1 or 2 minutes to get the oil thoroughly worked into the

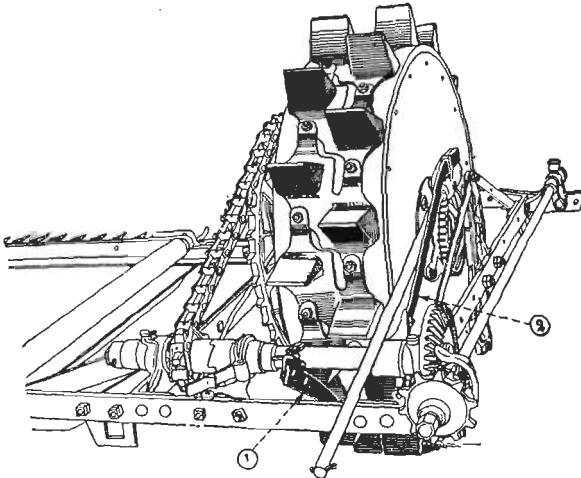


FIG. 455.—Main wheel and assembly for rice binder.

bearings; then, when it is put in the shed and left for several months, these bearings will not be rusted and probably stuck, requiring considerable length of time to get them in shape for the following season. In addition to this, as much of the dust and caked oil should be removed as possible before it is set away. Then, just at this time, when all the troubles that have been encountered during the cutting season are fresh, they should be set down on a piece of paper so that repairs can be readily made during the slack season. This is especially necessary where it is likely that the same operator will not be with the binder during the next season. The canvases should all be removed, cleaned, rolled up, and put where there is no danger of rats or mice cutting them.

496. Draft of Binders.—The draft of a binder is affected by the kind of grain being cut, the yield, the condition and type of soil, the grade and the condition of the binder. Therefore, the draft will vary greatly.

This variation may be from 60 to 100 pounds per foot in width covered. This would require 1.3 to 2.2 horsepower hours per acre.¹

497. Acres Cut per Day.—The number of acres of grain harvested per day will vary according to the conditions. A 4- to 7-foot binder

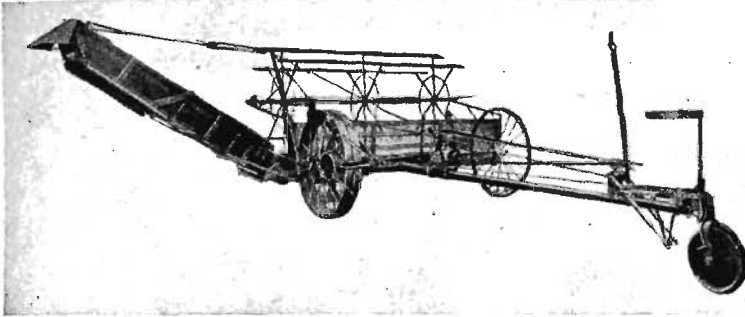


FIG. 456.—Grain header.

drawn by three horses will cut 1.79 acres per foot of width of cutter bar in a 10-hour day. A 5- to 8-foot binder drawn by four horses will harvest 2.08 acres per foot of width of cutter bar in a 10-hour day.¹

A tractor binder will harvest from 15 to 35 acres per day depending on conditions and size and rate of travel. A 10-foot binder traveling at the rate of 3 miles per hour will harvest 35 acres per 10-hour day.

THE HEADER

The header is a machine that is used to cut the heads from the grain instead of cutting all the straw (Fig. 456). The heads are elevated into wagon boxes and stacked and later threshed. Most of these headers are not equipped with the binding attachment but there are some that will bind the grain and are called *header binders*.

These machines will cut a strip varying from 12 to 20 feet in width and will

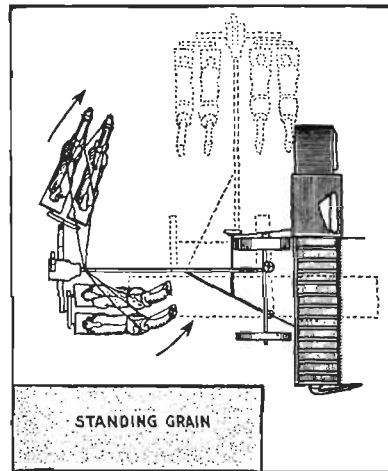


FIG. 457.—Method of turning push-binder or header.

require four to six horses to furnish the power. Instead of drawing the machine behind the team, as in the case of the regular binder, the header is usually pushed ahead of the team (Fig. 457). This will eliminate all side draft which is sometimes troublesome with the regular binder. There is also another type of machine for heading grain known as the *combined harvester and thresher*, which will be discussed in a later chapter.

¹ "Extension Service Handbook on Agriculture and Home Economics," U. S. Dept. Agr., 1926.

CHAPTER XXIV

CORN HARVESTING MACHINERY

CORN BINDERS

The corn binder was designed and built primarily for cutting corn. It is adaptable, however, for cutting many other row crops. Consequently, it is often called a *row binder*. There are two types of corn binders: the ground-driven horse-drawn and the power take-off tractor-operated.

498. Main Wheel.—The main wheel of the row binder differs very little from that of the grain binder. There are roller bearings in each end of the hub and also ball bearings to take care of end thrust. There is also a large

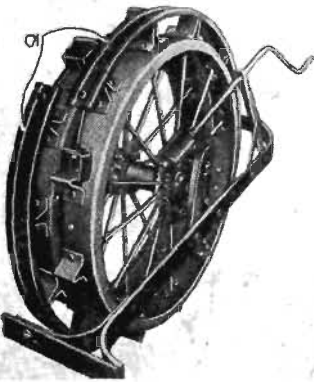


FIG. 458.—Transport rim to cover lugs on main wheel.

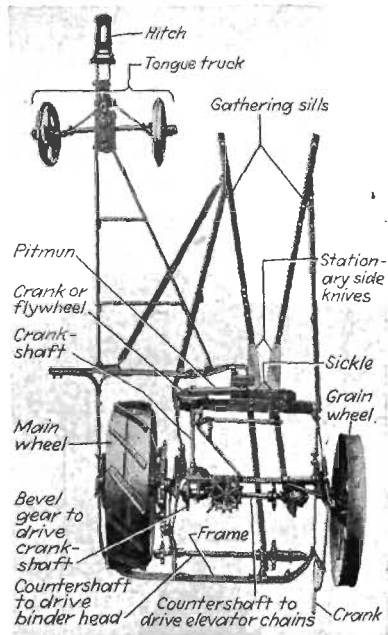


FIG. 459.—Frame, wheels, and tongue truck for horse-drawn corn binder.

sprocket or gear placed on the wheel, for transmitting the power to the countershaft. Figure 458 shows a transport rim to cover the lugs on the main wheel so the binder can be moved over highways.

499. Frame.—The frame (Fig. 459) of the binder is supplied with quadrants so that the gears on each end of the main axle can be moved up and down in the quadrants, raising and lowering the binder. The whole machine is so constructed that it is well balanced over the main and grain wheels.

500. Grain Wheel.—The grain wheel supports the side of the binder away from the main wheel and serves the same purpose as the grain wheel of the grain binder (Fig. 459). It is provided with roller bearings and is also placed in a quadrant so that the frame of the binder can be

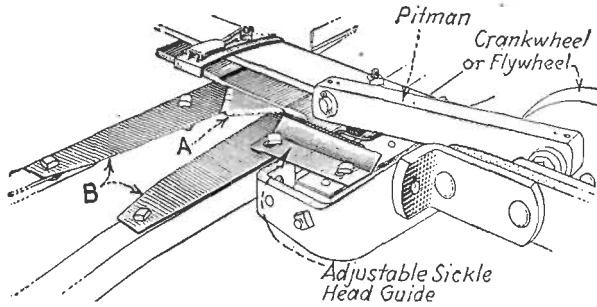


FIG. 460.—Cutting mechanism of corn binder: A, sickle; B, side knives.

raised or lowered. Extending from the outside from near the front of the right gathering board is a long stick called the *divider stick* which prevents any large stalks or heavy grass from collecting in between the wheel and the binder mechanism.

501. Countershaft.—The countershaft extends across the frame about midway. It has either a sprocket or a spur gear on the left end to

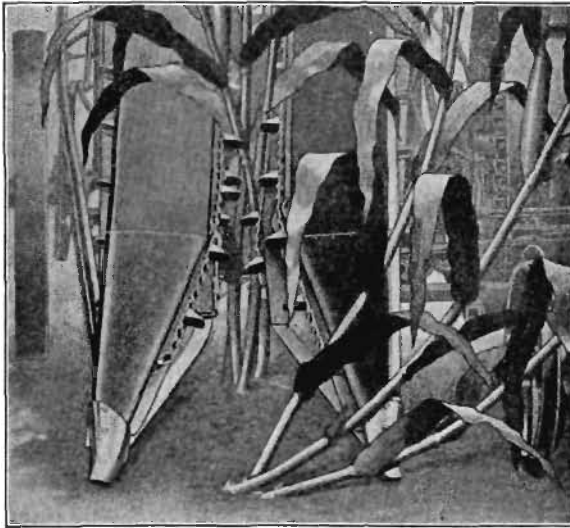


FIG. 461.—Gathering boards pick up leaning and down stalks.

transmit the power from the main wheel. There are bevel gears for driving the elevating chains, and the crank shaft and sprocket to drive the binder attachment (Fig. 459).

Roller bearings are used on this shaft.

502. Crank Shaft and Wheel.—This shaft and wheel are similar to those on a mower (Fig. 459). A bevel gear is placed on the rear end while the counterbalanced *pitman wheel*, *crank wheel*, or *flywheel* is on the front end.

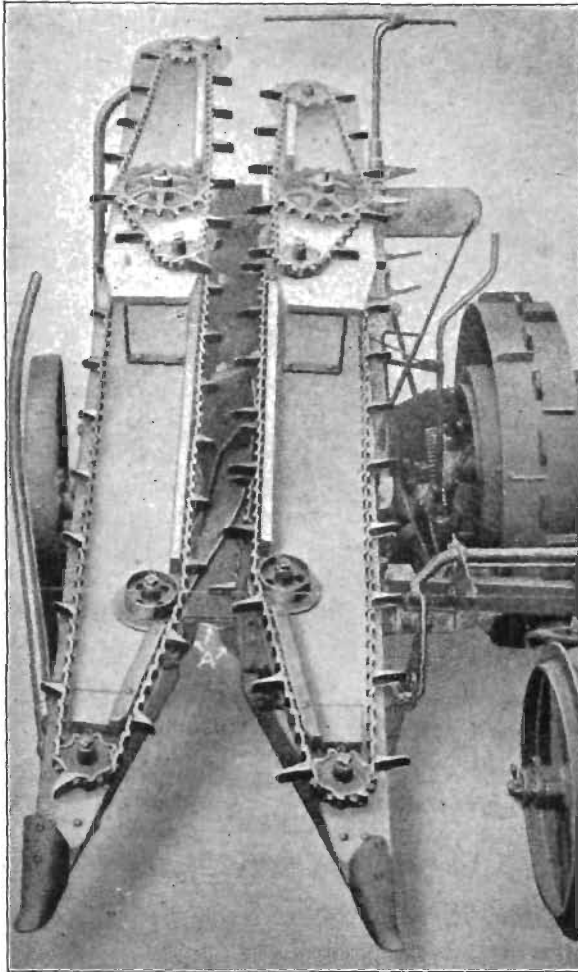


FIG. 462.—Overhead view of upper gathering chains.

503. Cutting Mechanism.—The cutting parts of a corn binder are subjected to very severe strains. They consist of two stationary side knives, one on either side of the throat (Fig. 460). They aid in cutting the stalks before they reach the sickle. These knives serve as the ledger plates and must be kept sharp. The sickle, roughly, consists of one serrated section which operates across and over the side knives. The two units should make a close shear cut. It is essential that the sickle

be held snugly in the guides provided, for the cutting unit to do its best work.

504. Gathering Sills and Boards.—The gathering sills extend several feet to the front of the cutting mechanism (Fig. 459). Attached to the front of these sills are the gathering boards. They incline upward and back over the machine at an angle of about 45 degrees (Fig. 463).

These boards can be tilted downward and lowered on the wheels so that any leaning down or tangled stalks can be picked up and saved.

505. Elevating Chains.—The elevating unit consists of six carrier chains, one chain on each of the four upper gathering boards (Fig. 462)—

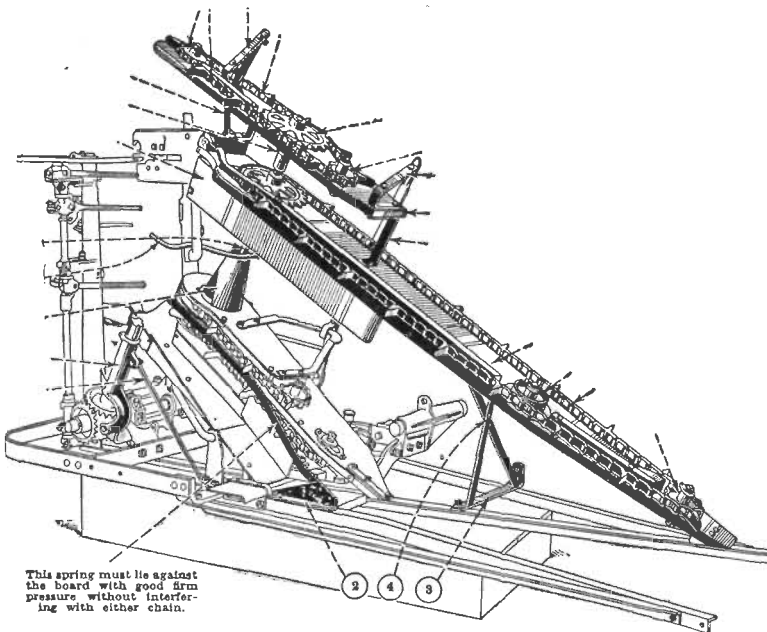


FIG. 463.—Side view of upper and lower gathering chains on left side of binder.

two on each side. There are two chains on the lower part of the inner gatherer. They are on the same side (Fig. 463). The purpose of these chains is to elevate the cut material from the sickle to the binding unit at the rear. Lugs on the chains serve as fingers to carry the stalks back. Long steel springs are provided in the lower part of the throat to hold the stalks against the lower chains (Fig. 463). The tension of the chains can be adjusted by moving the sprockets (Fig. 465). The chains on each side are operated independently by power received from the countershaft.

506. Binding Attachment.—The binding attachment, shown in Fig. 466, for the corn binder differs from that of the grain binder only in that it is built much heavier and placed in a different position. On

most corn binders it is set *vertically*, while on some of the others it is set *inclined* or *horizontally*. There are packers for packing the stalks against the trip hook and an adjustment for determining the size of the bundle;

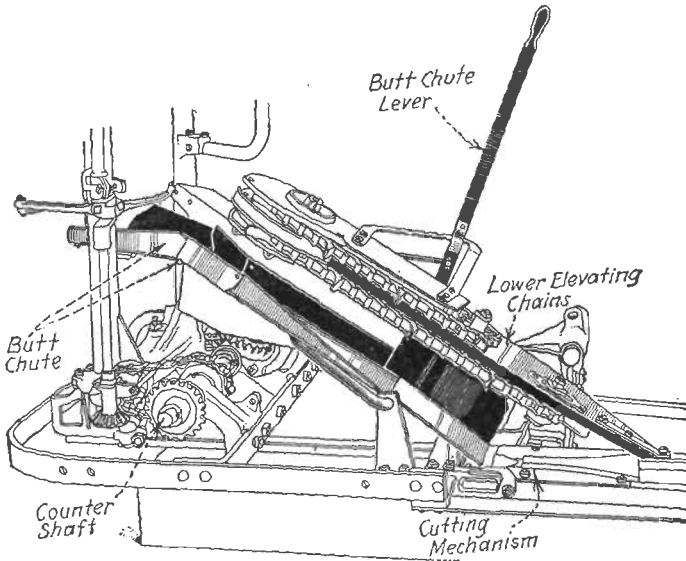


FIG. 464.—Butt chute in raised position.

needle and knotter head for tying the knot in the band placed around the bundle; and discharge arms for discharging the bundle after it has been tied.

507. Bundle Carriers.—All corn or row binders have bundle carrier attachments. These may be of the finger or carrier type shown in

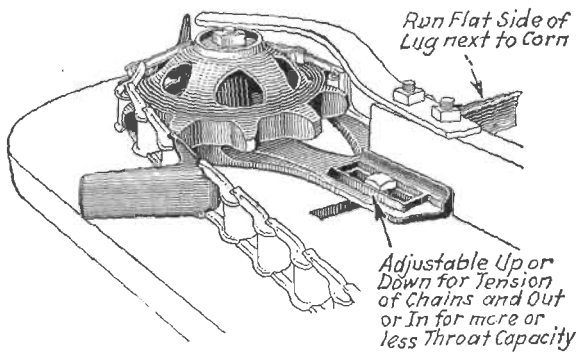


FIG. 465.—Method of adjusting tension on elevator chains.

Fig. 467. Since this type of machine is called upon to cut crops that are in the green stage or before they are ripe, they are rather heavy and, of course, the bundle carrier must be rather strong to carry a few

bundles until they are dumped. As a general rule, only one or two bundles are allowed to collect upon the carrier before it is dumped.

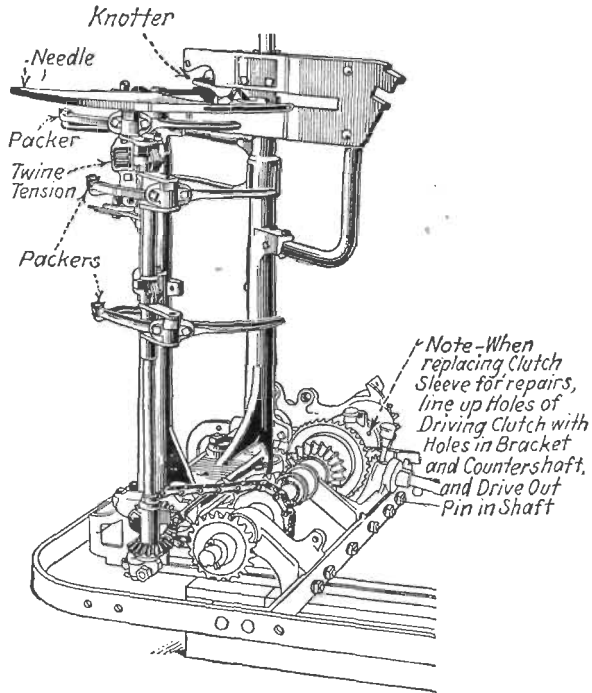


FIG. 466.—Binding attachment for corn binder.

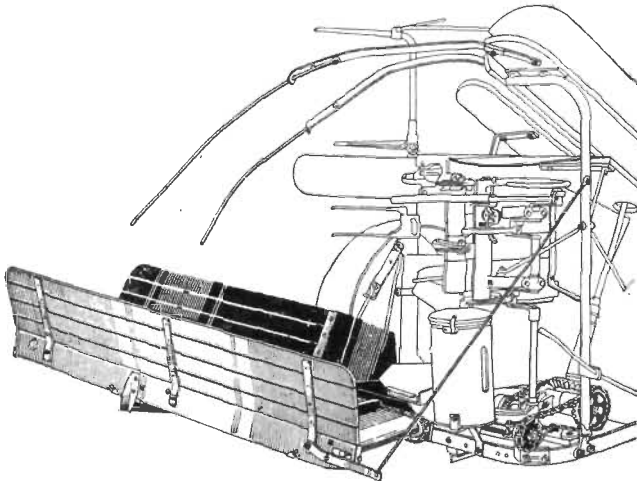


FIG. 467.—Bundle carrier.

508. Bundle Elevators.—Large bundle loaders, as shown in Fig. 468, can be secured to elevate the bundles directly to the wagon or truck

traveling alongside the binder. Such a carrier would be a great labor saver in handling material being cut for silage.

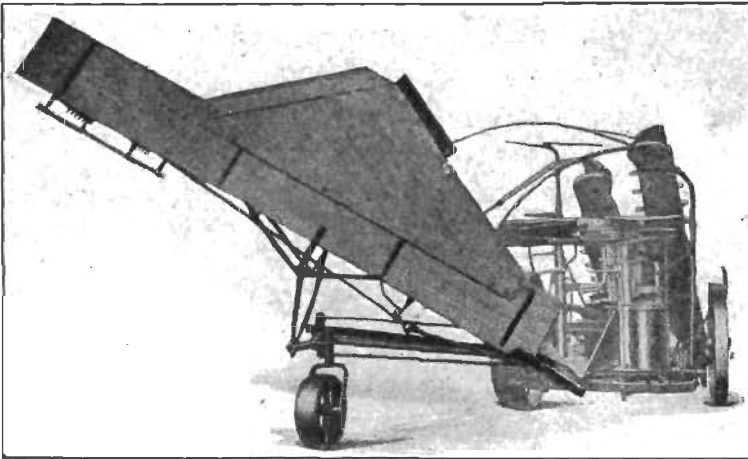


FIG. 468.—Bundle elevator.

509. Tractor Corn Binders.—Horse-drawn ground-driven corn binders are often hitched to a tractor, but the regular tractor corn binder is tractor-drawn and operated from the power take-off (Fig. 469). Most tractor corn binders are one-row types, but several companies are now



FIG. 469.—Overhead view of a tractor corn binder with bundle elevator, wagon hitch, and wagon in position.

offering a two-row machine (Fig. 470). Tractor binders are available in both the short and long types.

Power is transmitted from the tractor through the power take-off shaft, and transmission gears to a countershaft, and then through sprockets and

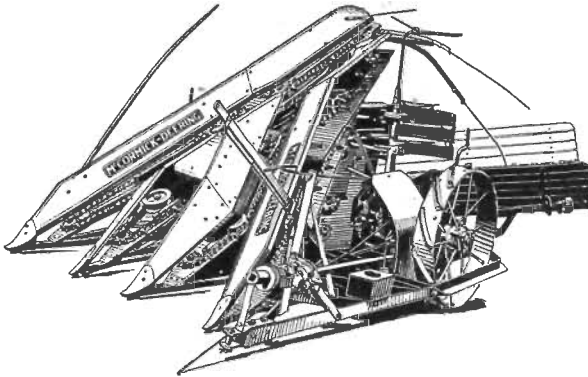


FIG. 470.—Two-row tractor corn binder.

roller chains to different parts of the machine (Fig. 471). The drive shaft is equipped with universal joints and safety-snap clutch. The bearings are equipped with pressure fittings for lubrication.

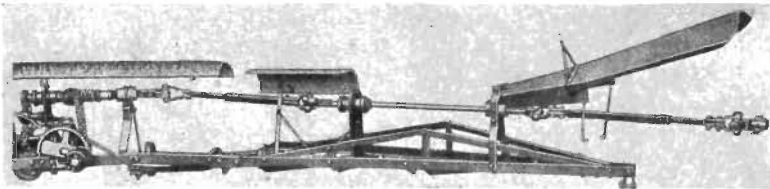


FIG. 471.—Power take-off shaft and support for the operation of a corn binder.

510. Corn-borer Attachment.—In fighting the corn borer it is important that the stalks be cut below the surface of the ground to destroy all larvae. Several low-cutting attachments for corn binders, similar to the one shown in Fig. 472, have been developed.

511. Acres Cut per Day.—Under normal conditions a row binder drawn by three horses can cut about 7 acres in a 10-hour day.

512. Cost of Use.—Tolley¹ states that the average life of a row binder is 11 years, but during that time it will do only, perhaps, 40 days' actual work. He further states that there is little relation between the amount of work done annually and the years of service. The cost per day used or per acre cut is very nearly in inverse ratio to the

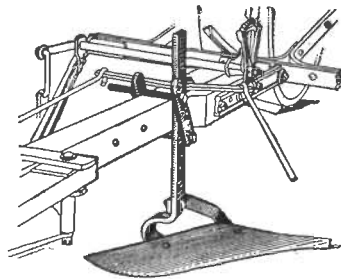


FIG. 472.—Low-cutting attachment for corn binder.

¹ U. S. Dept. Agr. *Farmers' Bull.* 992, p. 10, 1918.

ground covered annually. Out of 458 binders on which data were obtained in western New York, 223 cut 15 acres or less annually . . . at a cost of \$9.78 per day. The remaining 225 cut 15 acres annually, averaging $32\frac{1}{2}$ acres, at a cost of \$3.24 per day of service and 57 cents per acre.

513. Other Methods of Harvesting Row Crops.—In addition to that of the row binder, crops that have been planted in rows may be harvested either by *cutting by hand* or by *sled cutters*.

Cutting by hand is a very slow and laborious method of harvesting. Where only a small acreage is to be harvested, however, this is sometimes the most economical method to use. One man with an ordinary, long, straight, corn knife or cane knife can cut, on the average, about 1 acre a day. If a considerable amount of cheap labor can be secured, a saving over the other method is had.

Another method of cutting row crops is with the use of the horse-drawn sled cutter. The United States Department of Agriculture, *Farmers' Bulletin* 303 describes several types of inexpensive sled corn cutters similar in construction, which, by the use of a horse or horses hitched one in front of the other, will enable two men to cut and shock corn more rapidly and with less fatigue than by hand. In some cases, the cutter is drawn on runners as a sled; in others, they are mounted on wheels. A man on each side catches the stalks as they are cut and when the shock row is reached the horses are stopped and the fodder placed in the shock. A man with a little skill can construct such a cutter on the farm. By means of adjustments at the point at which the wheels are attached, the knives can be elevated or lowered to cut the corn the desired height. There are no expenses for twine or repairs and but little outlay for machinery. The most up-to-date types of the sled cutters are machines that will cut two rows, having a divider extending out to the side and front with chains to assist the tops of the stalks up and back. The corn is cut with a reciprocating knife and carried back by chains and dropped on a platform. When enough has been collected to form a shock, the team is stopped and the corn set up.

One of the biggest disadvantages of the average sled type of corn cutter is that it can be used only when the corn stands straight. Where a stationary knife is depended upon to cut the stalks, the horse must walk rather fast in order that the work be done with any degree of proficiency.

CORN PICKERS

The corn picker is a single- or double-row machine, equipped with snapping rolls to remove the ears from the standing stalks. The early machines snapped the ears off the stalks without removing the husks,

but the modern machine performs two operations. It not only removes the ears from the stalks but also removes the husks from the ears, delivering the clean ears to a trailer wagon or into an elevated tank.

Power-driven corn pickers were first constructed to be *pulled* behind the tractor (Figs. 473 and 476), but a recent innova-

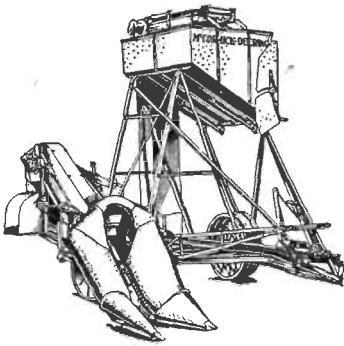


FIG. 473.—One-row pull-type corn picker.

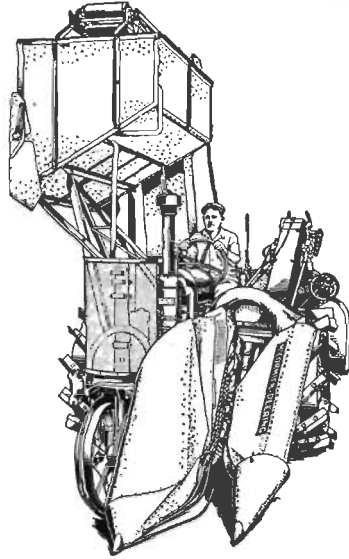


FIG. 474.—One-row push-type corn picker.

tion is the *push*-type mounted on the tractor (Figs. 474 and 475). Both



FIG. 475.—Two-row push-type corn picker in operation.

types are available in the one-row and two-row sizes. The one-row machines may be equipped with tanks to receive the ears, but the two-

row machines elevate the ears into a wagon trailed behind or to the side of the picker.

514. Snapping Rolls.—The corn stalks are gathered up and led into the snapping rolls with the aid of gathering chains (Fig. 477). As the

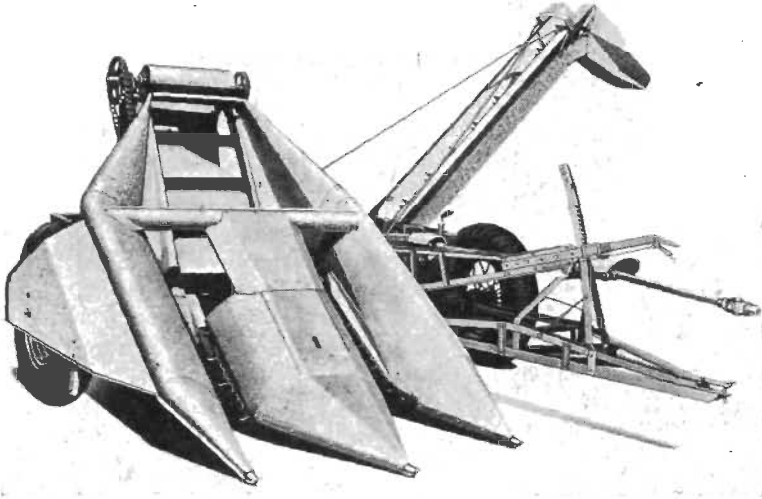


FIG. 476.—Two-row pull-type corn picker.

stalks pass between the revolving rolls, the ears are snapped off and dropped into a conveyor trough (Fig. 478), which carries them to the husking unit. The rolls have a spiral rib or ridge extending from the

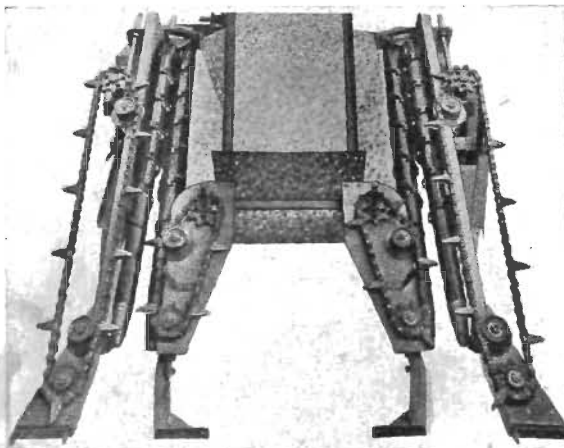


FIG. 477.—Snapping rolls and gathering chains for two-row corn picker.

front end, or almost the front end, to the rear end. As the top sides of the two rolls revolve toward each other, the ears are caught between the small rolls and pinched off. The roll next to the conveyor is set lower than the other roll, and as the ear is snapped off, it topples off the

rolls into the conveyor trough. The rolls are adjusted according to the condition of the corn; if damp, the rolls are run close together and if dry, the rolls are spaced farther apart.

515. Husking Rolls.—The husking rolls, as shown in Fig. 479, operate in pairs with each pair held together under spring pressure which can be regulated. There should be just enough tension on the rolls to cause them, with the aid of the husking pegs on the rolls, to grasp the husks and pull them through the rolls so that the ears are stripped clean with a minimum amount of shell-

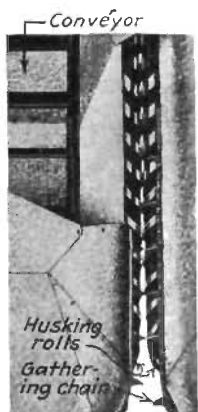


FIG. 478.—Snapping rolls and conveyor for corn picker.

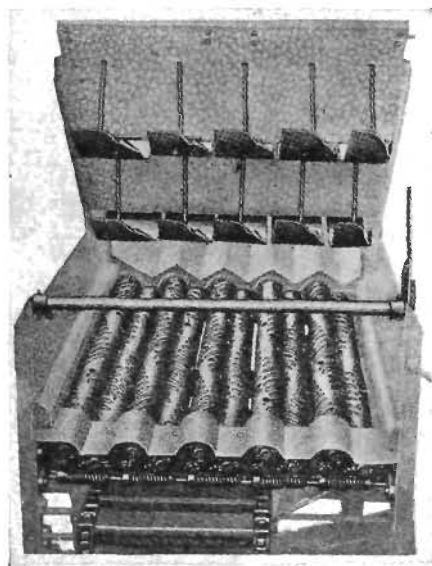


FIG. 479.—Husking rolls for two-row corn picker. The cover is raised to show the rolls and the retarding plates on the cover.

ing. Pressure on the retarding plates can be adjusted for large and small ears. The number of rolls in a husker ranges from 8 to 12.

Some corn pickers are equipped with a fan to blow the husks and trash off the husking rolls.

Any corn shelled by the husking rolls is cleaned as it drops into the grain saver.

516. Wagon Elevator. The wagon elevator receives the clean ears from the husking rolls and carries them up and drops them into the tank or into the wagon. Tanks do not have sufficient capacity for the two-row machines, hence wagons are used.

517. Clutches. Snap or slip clutches are provided on the main drive shaft, the gatherers, the elevator from picking to husking rolls, the husking rolls, the husk conveyor, and the wagon elevator.

518. Harvesting Costs.—The three following tables on the cost of harvesting and cribbing corn are reproduced from Indiana Agricultural Experiment Station Bulletin 362.

TABLE XIV.—COSTS OF HUSKING AND CRIBBING CORN BY THREE METHODS, 1929, 1930 AND 1931

Method	Dollars per acre			Cents per bushel		
	1929	1930	1931	1929	1930	1931
Hand husking.....	3.98	3.62	2.97	10.0	8.7	6.1
One-row pickers.....	3.41	3.15	3.09	8.8	8.1	6.0
Two-row pickers.....	2.42	2.29	2.39	5.9	5.4	5.0

TABLE XV.—LABOR, POWER AND MACHINERY REQUIREMENTS FOR HUSKING AND CRIBBING AN ACRE OF CORN BY THREE METHODS, 1929, 1930 AND 1931

Method	Man labor, hours	Horse work, hours	Wagon use, hours	Tractor use, hours	Picker use, hours
Hand husking.....	5.35	10.79	5.26		
One-row picker.....	2.98	3.60	2.57	1.20*	1.19*
Two-row picker.....	2.10	2.67	1.82	.72*	.71*

* Differences between the figures for tractor and for picker use were caused by two men using two tractors, one pulling the picker and the other drawing the loaded wagons to the crib.

TABLE XVI.—YIELD PER ACRE AND CORN-PICKING COSTS, 1929, 1930 AND 1931

Yield group	Average yield, bushels	Man-hours per acre	Bushels picked per man-hour	Cost per acre	Cost per bushel
One-row pickers					
Farms with lowest yields.....	38	2.89	13.2	\$3.16	8.5¢
Farms with highest yields.....	50	3.10	16.1	\$3.28	6.7¢
Two-row pickers					
Farms with lowest yields.....	35	1.90	18.7	\$2.21	6.3¢
Farms with average yields.....	44	1.93	22.9	\$2.43	5.5¢
Farms with highest yields.....	54	2.05	26.4	\$2.49	4.6¢

"The yield per acre was one of the most important factors which affected the cost of husking a bushel of corn with mechanical pickers. Yields had little effect on the amounts of time and materials required to pick an acre, and costs per acre were but slightly higher on the farms which had high yields of corn. Costs per bushel were much lower when high yields were secured.

Hand husking was usually hired on a bushel basis and high yields were associated with proportionally higher costs per acre, with costs per bushel remaining practically unchanged."¹

¹ *Ind. Agr. Expt. Sta. Bull.* 362, p. 8, 1932.

CHAPTER XXV

MISCELLANEOUS HARVESTING MACHINERY

COTTON HARVESTERS

The types of harvesting machines taken up in this chapter will be those not adapted to such a large area as those discussed in previous chapters. Such harvesting machinery as cotton pickers, peanut pickers, potato diggers, and pea harvesters will be discussed as miscellaneous harvesting machinery.

COTTON PICKERS

The ingenuity of man has not yet overcome the difficulties of picking cotton by machinery. In recent years many attempts have been made



FIG. 480.—Weighing bags of hand-picked cotton. Note the tractor hitched to a home-made four-wheel trailer. When 1,200 to 1,500 pounds of seed cotton have been picked, the trailer is pulled out of the field and the family automobile hitched to it and the cotton carried to the gin.

to invent a machine that will eliminate the drudgery of picking cotton by hand (Fig. 480). Several of the machines that have been invented will pick cotton to a certain degree, but none of them have proved economically successful. If the plants were of uniform height and if the fruit ripened uniformly, success might be obtained, but the plant varies in height from 2 or 3 feet to 8 or 10 feet; and the fruit ripens from June to November. Even when the fields are ready for the first picking, the plants are still loaded with young tender bolls of all stages of growth which are likely to be injured by a machine picker. Hand picking goes

on as in the centuries past but there is in sight a promise of relief from the most tedious and expensive process connected with the cotton crop; namely, that of gathering the seed cotton from the boll.

Efforts of inventors to develop machinery for harvesting cotton have been along three different lines: first, vacuum; second, mechanically; and third, combined vacuum and mechanical.

519. Vacuum Picker.—The vacuum cotton picker consists of two vacuum tanks, each 10 feet long and 2 feet in diameter, equipped with a powerful rotary vacuum pump. These tanks are mounted on an ordinary

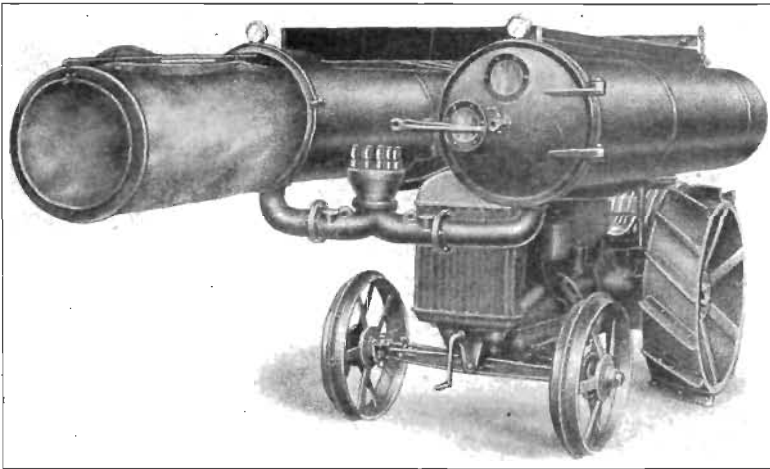


FIG. 481.—Vacuum cotton harvester.

farm tractor which also furnishes power for operating the vacuum pump (Fig. 481). Six inlets are connected with the tank and to these inlets are attached six metal reinforced rubber hose. At the end of each hose is a nozzle equipped with a valve which, when opened, permits an inrush of air. When the vacuum pump is placed in operation by the tractor, the air is drawn from the tanks which action in turn draws the air through the hose, permitting the cotton, when the nozzles are placed near the boll, to be drawn into the hose and from there into sacks which fit into the tanks. This machine requires seven men for a complete crew—one to drive the tractor and six to operate the nozzles. There are 12 nozzles in all—one for each hand of the six operators. To pick the cotton with these machines, these nozzles must be directed toward each boll of cotton so that the inrushing air will at the same time draw in the cotton from the boll. The cotton, as it is sucked from the boll, is carried directly into one tank and when it is full, the feed is shifted to the other tank, while the cotton from the first tank is being emptied by the removal of the full sack.

This is only one of many similar attempts to use a vacuum or suction for the picking force.

520. Combined Mechanical and Vacuum Picker.—This type of machine uses a combination of air suction and a mechanical device as a means to pick cotton. Figure 482 shows a picker head attached to an air hose. The small flexible shaft operates two inwardly revolving fluted wheels, which when placed in contact with a boll of cotton (Fig. 482) whip the cotton out of the boll into a stream of air, which sucks the cotton into the hose where it is carried to the hopper or bag.



FIG. 482.—Picking head of a combined mechanical and vacuum picker.

A small gas engine furnishes power for operating the machine.

521. The Mechanical Picker.—The mechanical cotton picker is a machine for picking the cotton from the bolls similar to hand picking. Of

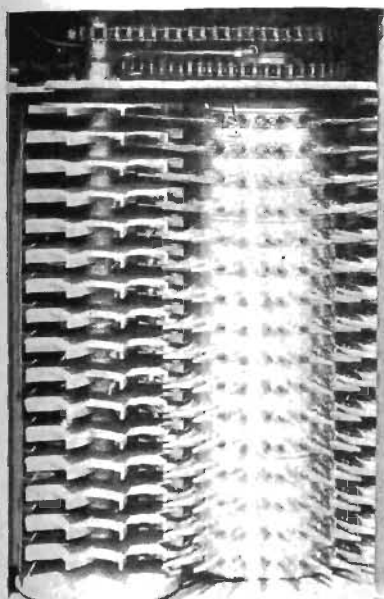


FIG. 483.—Vertical drum of cotton picker equipped with grooved spindles and serrated teeth. The doffer is the drum on the left.

the numerous devices that have been tried as picking units, only a few have shown promise of success. Three are described: First, the grooved spindle with serrated teeth overhanging the groove (Fig. 483); second, the double-pointed corkscrew unit (Fig. 484); and third, the damp smooth-wire spindle. The machine shown in Fig. 485 is equipped with the smooth-wire spindle.

For any machine to do efficient picking, the cotton must be in good condition. The bolls must be well open with the cotton dry and fluffy and protruding out of the boll far enough to permit the picking unit to catch, twist or roll, and pull out the cotton. The locks of cotton must easily pull from the boll or tags will be left hanging in the boll because the fibers pull loose between seed.

Cotton-picking machines may consist of self-propelled units, tractor-mounted push types, or the pull type of machine drawn to the rear and side of the tractor. The picking units consist of arms or spindles radiating from a vertical cylinder or a wide belt. The picking spindles extend

horizontally from the drum or belt and are caused to revolve by a gear or friction drive. The rotation of the drum or belt is synchronized with the forward movement of the machine so that the picking units enter

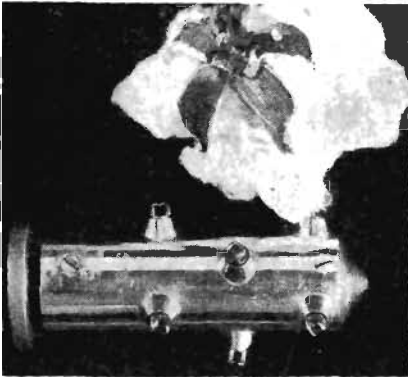


FIG. 484.—The double-pointed corl-screw picking units catch the cotton, twist and pull it out of the boll, then reverse to release it.

the plant from one or both sides, catch whatever cotton they may contact, and withdraw without stripping or tearing through the plant. Any cotton caught by the spindle remains on it until the revolving drum or belt carries the spindles through stationary or revolving doffers located on the outside of the drum. The cotton drops upon a conveyor, which elevates it to a suitable receptacle.

522. The Stripper Cotton Harvester.—The stripper type of cotton harvester has been used to harvest cotton in northwestern Texas and

western Oklahoma. The stripper simply strips off the whole boll containing the cotton and does not attempt to pick the cotton from the bolls while attached to the plant. The separation of the cotton from the bolls, burs, and trash is accomplished by an extractor unit, which is either a part of the harvester or a part of the gin.

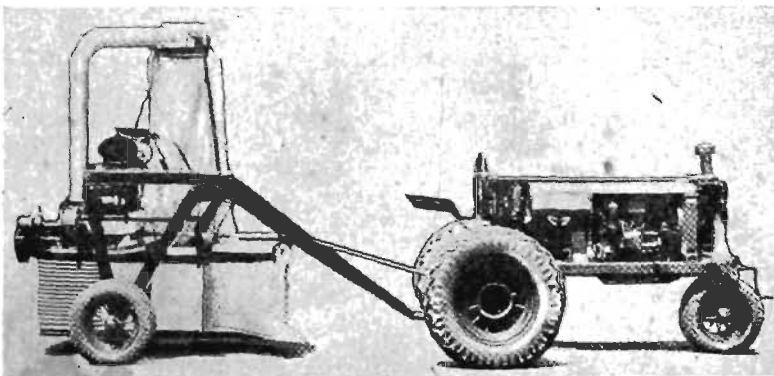


FIG. 485.—Pull-type tractor-drawn and power-driven cotton picker that picks with a damp smooth-wire spindle.

Stripping cotton with machinery is a substitute for *hand snapping* or *hand pulling*. That is, no attempt is made to pick the cotton out of the boll. The boll is *snapped* or *pulled* off.

Typical homemade one- and two-row sled cotton strippers are shown in Fig. 486. The machine shown in Fig. 487 is a tractor-mounted pusher-

type stripper developed by the author at the Texas Agricultural Experiment Station. The machines shown in Figs. 488 and 489 are commercial machines.

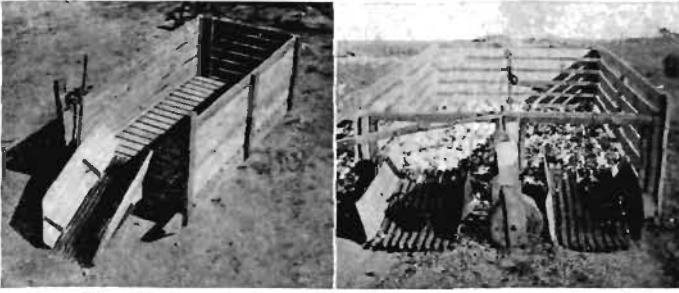


FIG. 486.—Typical single- and double-row cotton-harvesting sleds.

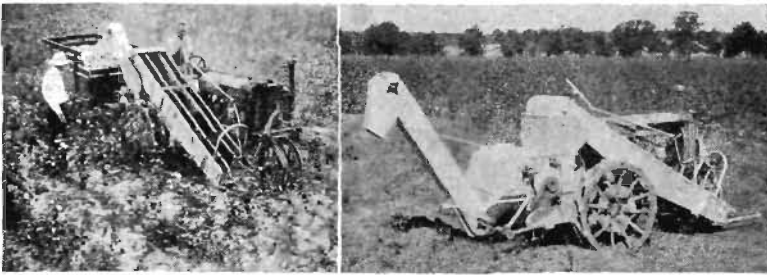


FIG. 487.—Two views of the Texas Station cotton harvester as it was used in 1935.

When smooth stripping rolls made of wood, steel, and rubber, were used in the Texas Station Harvester at three roll speeds, and set at an angle of approximately 28 degrees, the highest percentage of the cotton was harvested with the highest roll speed. Similar results were secured when rubber rolls and knurled surfaced steel rolls were compared at different speeds. The rubber rolls operated at high roll speed harvested 96.8 per cent with Ducona cotton and 95.5 per cent with Lone Star cotton, while the knurled surfaced steel rolls harvested 96.2 per cent with Ducona and 97.0 per cent with Lone Star.

Comparisons of the effect of roll speeds indicate that a higher percentage of the cotton is harvested with a high roll speed.

When the effects of tractor speeds were compared, the average percentage of the cotton harvested was 96.0, 95.5, and 94.7 per cent for low, second, and high tractor gear speeds, respectively. The feet travel of the roll surface per foot of

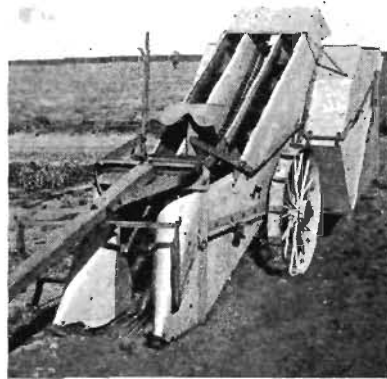


FIG. 488.—One-row horse-drawn cotton stripper.

tractor travel was 1.02 feet for low, 0.68 feet for second, and 0.50 feet for high tractor gear speeds.¹

523. Cost of Harvesting Cotton.—In discussing the cost of harvesting corn with machinery it was shown that the yield per acre had little effect on the cost per acre but did materially affect the cost per bushel. Likewise, the yield per acre of cotton affects the harvesting cost per pound or per bale, but the cost per acre will remain more constant, as the amounts of time, labor, and materials required per acre were about as much for harvesting low yields as for high yields.



FIG. 489.—Two-row push-type tractor mounted and driven cotton stripper.

Table XVII gives a comparison of the cost of hand snapping and machine harvesting.

TABLE XVII.—THE AVERAGE APPROXIMATE COST OF HARVESTING AND GINNING HAND-SNAPPED AND MECHANICALLY HARVESTED COTTON IN NORTHWEST TEXAS—1932¹

Method of harvesting	Pounds required to make a 500-pound bale of cotton	Harvesting cost		Ginning cost		Total cost
		Per 100 pounds	Per bale	Per 100 pounds	Per bale	
Hand snapped.....	2100	\$0.75	\$15.75	\$0.50	\$10.50	\$26.25
Machine (Texas Harvester) ..	2200	.....	3.08	0.50	11.00	14.08
Difference in favor of machine harvesting.....	.....	.....	.....	.....	.....	12.17

¹ Snapped cotton usually applies to gathering open cotton, burs and all, by hand.

524. Factors That Affect the Efficiency of Harvesters.—The characteristics of the cotton plant linked with varietal characteristics are the most important factors that influence the efficiency of cotton-harvesting machinery. These characteristics include the size of the plant, amount

¹ *Texas Agr. Expt. Sta. Bull.* 511, p. 17, 1935.

of foliage, number and length of branches, size of bolls, size and brittleness of peduncle of boll, manner in which boll opens, storm resistance, and the degree to which the fibers between seed are interlocked or tangled.

Other factors are: field conditions, field topography, soil type, and climate.

Machine factors are: kind of picking unit, manner in which the unit is presented to the plant, flexibility of the machine, adjustable features, and general design.

POTATO DIGGERS

At the very best, the harvesting of the potato crop is a slow, tiresome, dirty task. There are two classes of potato diggers: walking and riding.

525. Walking Potato Diggers.—Figure 490 shows an ordinary walking middlebreaker which has rods substituted for the moldboards.

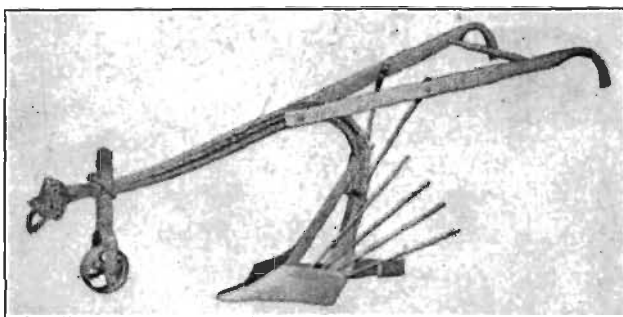


FIG. 490.—Walking potato digger.

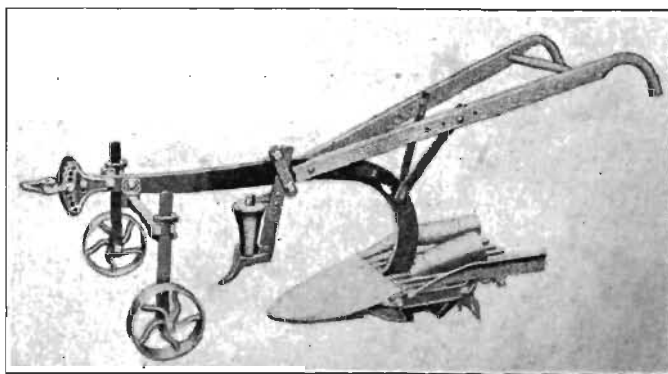


FIG. 491.—Walking shaker potato digger.

A much improved walking potato digger is shown in Fig. 491. The shovel is a large rounded scoop which slides under the potatoes scooping the soil and the potatoes up onto the shaker grate at the rear. The grate is hinged at the front. A five-pointed wheel under the grate gives it an up-and-down motion which sifts the soil from the potatoes as

they pass over the rods. A forecarriage to control the depth of the shovel is fastened to the front of the beam. A fender to clear away the weeds and vines is suspended from the beam in front of the shovel.

526. Riding Potato Diggers.—The digger shown in Fig. 492 may be considered as a standard one-row ground-driven horse-drawn potato-

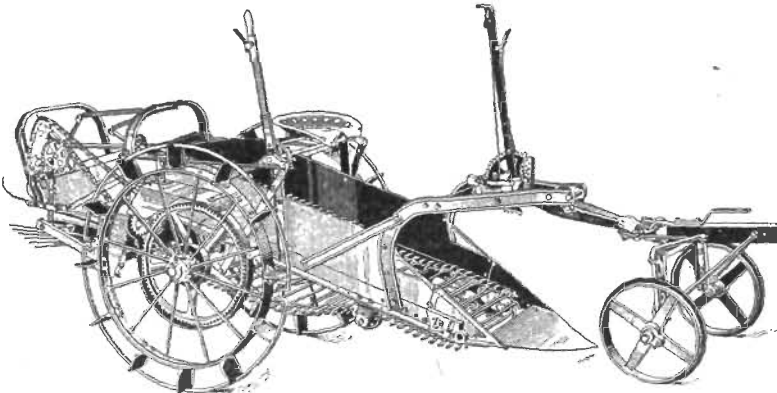


FIG. 492.—Standard one-row riding potato digger.

harvesting machine. It is commonly called an *elevator digger*. The potatoes, vines, and soil are scooped up by the shovel onto the elevator.

The elevator is made up of bent rods forming an open carrier chain. Each alternate link is raised and lowered to form pockets to elevate the potatoes. As the elevator revolves, it is agitated by elongated or oval-shaped sprockets (Fig. 493) which give the elevator a brisk up-and-down motion to shake out the soil. The potatoes and vines are carried back to the rear shaker and vine turner (Fig. 494) which deflects the vines to the side, leaving the potatoes and vines separated on the ground. Two drive wheels equipped with large lugs furnish power for the elevator, the power being transmitted by means of gears and shafts.

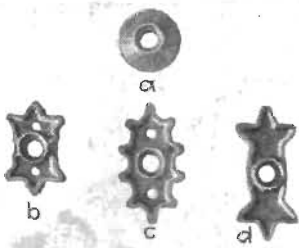


FIG. 493.—Agitator sprockets used on potato-digger aprons: A, for loose sandy soil; B, and C, provide normal agitation; D, for extreme agitation.

527. Tractor Potato Diggers.—Potato diggers like many other machines have been adapted so that they may be drawn and operated by tractors. Figure 495 shows a one-row tractor-power take-off driven potato digger, and Fig. 496 shows a two-row machine. The one-row machine is hitched to the tractor at the left side, but on the two-row digger the hitch is ahead of the center of the machine.

Both the one-row and two-row machines can be provided with a change of speed transmission, so that the speed of the apron can be changed.

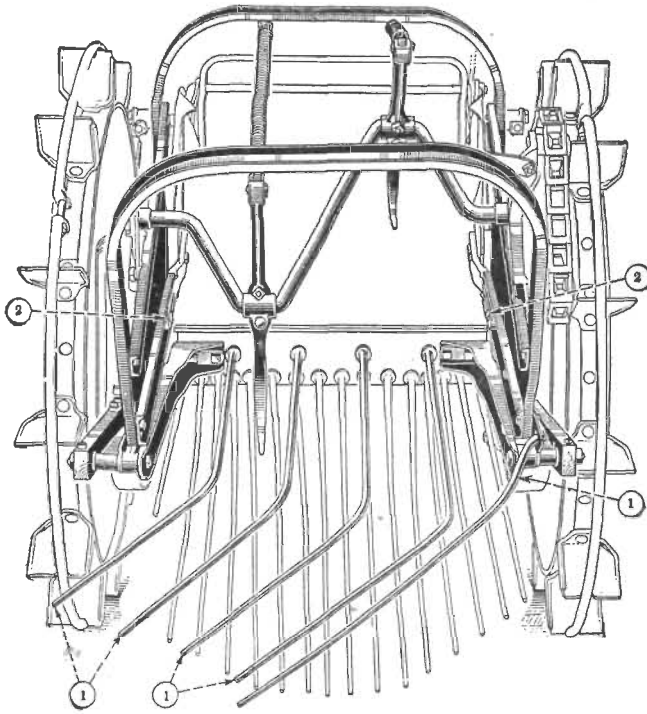


FIG. 494.—Vine turner and shaker.

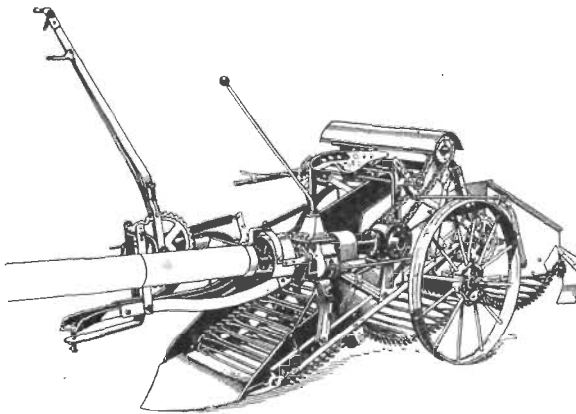


FIG. 495.—One-row tractor-drawn and power take-off driven potato digger.

A two-row potato digger recently developed has a single plow and elevator.

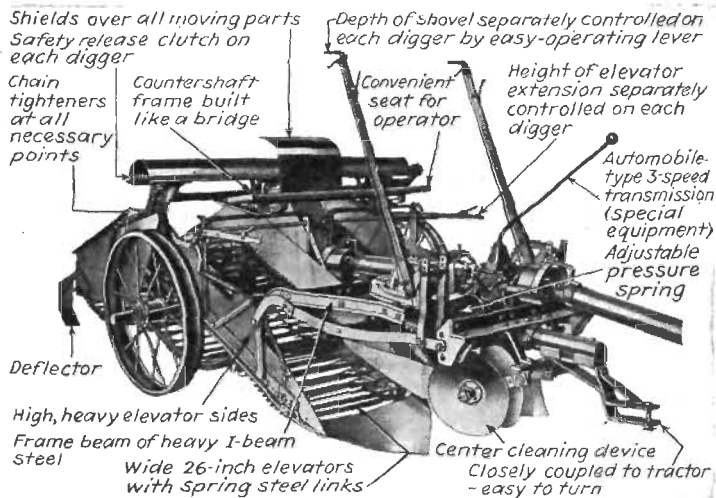


FIG. 496.—Two-row tractor-drawn and power-driven potato digger.

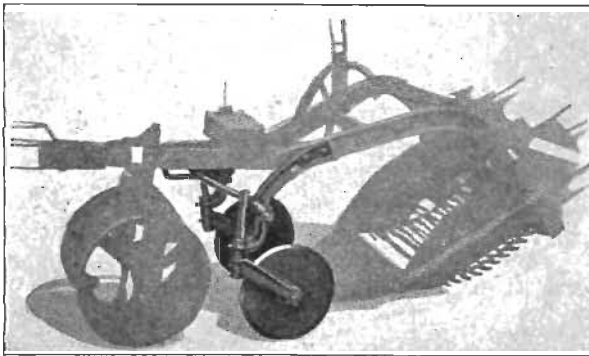


FIG. 497.—Rolling coulters on potato digger to cut vines when used to dig sweet potatoes.

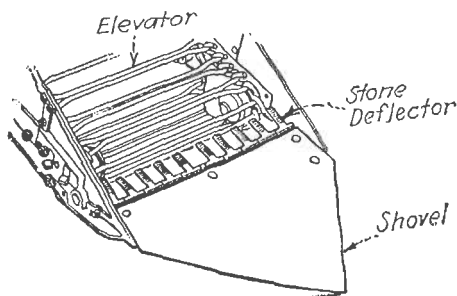


FIG. 498.—Stone trap.

528. Attachments.—A tongue truck aids in controlling the depth and makes turning in a short place easy.

Rolling coulters, as shown in Fig. 497, are helpful where the ground is covered with running vines and weeds or for digging sweet potatoes.

A stone trap can be used to advantage where the field is stony (Fig. 498). An auxiliary engine can be mounted on top of the digger to operate the elevator, where the digging is extra heavy.

529. Baggers.—Special bagging machines are being used to some extent but are not yet considered as regular equipment. The bagger is a separate unit and is attached behind the digger. The potatoes are dropped from the digger onto the bagger elevator which elevates and drops them into a bag or crate.

PEANUT DIGGERS

The digging of peanuts is the removing of the peanut and the vine from the soil. The type of instrument used to uproot them varies from a one-horse turning plow to a machine potato digger. If the one-horse turning plow is used, the moldboard should be removed. When the moldboard is left on the plow, there will be a tendency to cover the vine as the furrow is rolled over.

530. Peanut Diggers.—United States Department of Agriculture *Farmer's Bulletin* 431 describes the following homemade peanut digger.

This digger is constructed usually upon the plan of an ordinary plow but having a U-shaped blade or cutter with one edge sharpened and so mounted that it may run underneath the plant. It is desirable to use a double team, straddling the row so that the digger will run at uniform depth. Almost any blacksmith can construct a tool of this kind at a very small cost. Any device that will sever the roots of the peanut plant just below where the peanuts are formed will answer the purpose and prove better adapted to the work than the plow.

Many peanut growers are now using the regular potato-digging machine which is drawn by two or three horses, having one man to drive the team and operate the digger. This machine removes the peanuts from the ground, shakes the soil off, and leaves the vines with the peanuts hanging to them lying upon the surface of the ground. Not as many pods are lost when the machine digger is used as when the plow and hand method is used.

HARVESTING SWEET POTATOES

The sweet potato has long tangled vines which make harvesting difficult. It is necessary that these vines be cut, before any machine can be used to uproot the potatoes.

The regular potato diggers can be used to good advantage where a coultter or special cutter is attached to the machine to cut the vines.

BEET DIGGERS

A machine especially designed to pull and lift the beet roots out of the soil is shown in Fig. 499. Both walking and riding types are exten-

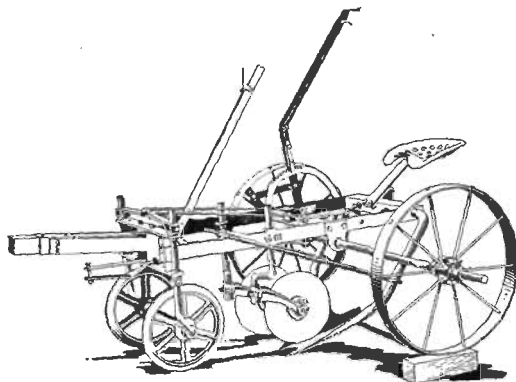


FIG. 499. Horse-drawn beet digger.

sively used. The California Agricultural Experiment Station is developing a beet digger that will dig the plants out of the ground, elevate them, and automatically cut off the tops.

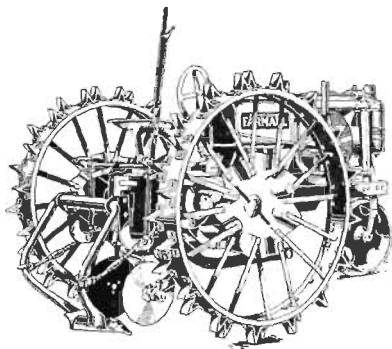


FIG. 500.—Beet digger attached to tractor.

PEA HARVESTERS

The pea pods which are necessary for seed for the next crop must be picked from the vines. Special pea pickers have been introduced in some sections of the country. One type of pea harvester has a winged drum revolving rapidly over a stationary or moderately sharp edge. The pods are knocked back upon a platform and then elevated into a bag.

Peas are also harvested by cutting the vines with a mowing machine. When thoroughly dry, they are run through a threshing machine where the peas are threshed from the vines.

HARVESTING SOYBEANS

Soybeans can be harvested with either the pea harvester or the combined harvester-thresher.

Heitsbu¹ in his study of soybean harvesting gives four methods:

¹ *Agr. Eng.*, Vol. 9, p. 209, 1928.

MISCELLANEOUS HARVESTING MACHINERY

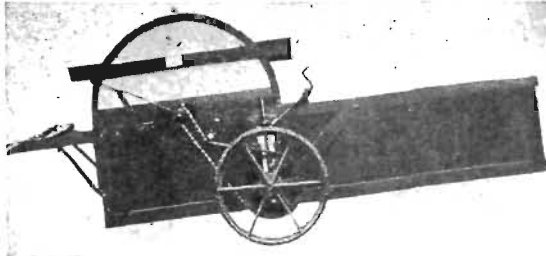


FIG. 501.—One-row horse-drawn soybean and pea harvester.

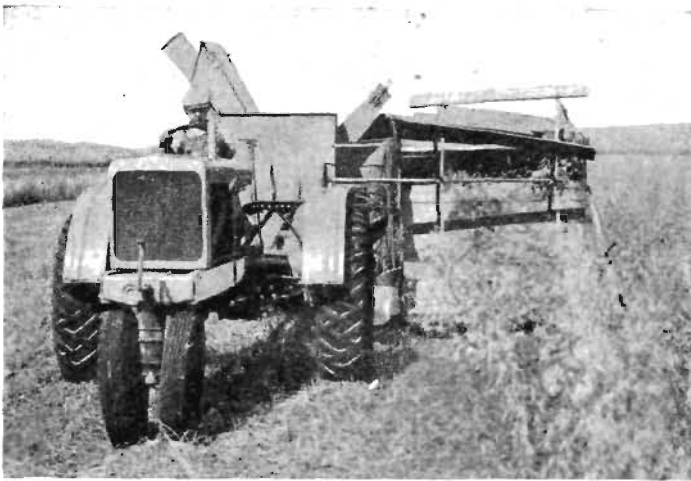


FIG. 502.—Harvesting soybeans with small combined harvester-thresher.

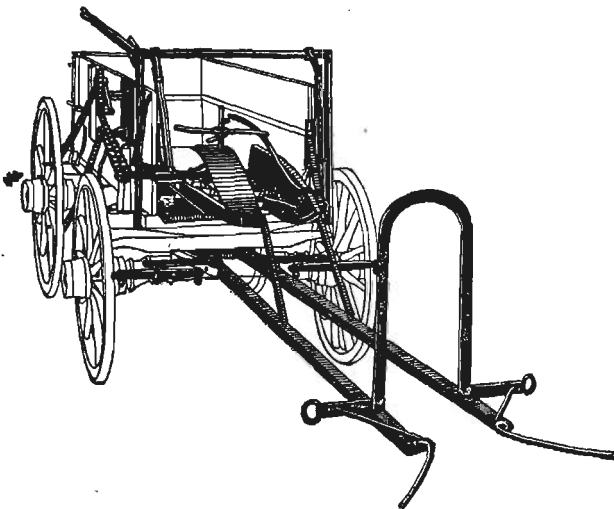


FIG. 503.—Grain-sorghum header.

1. The cut and thresh.
2. The row harvester.
3. The broadcast harvester.
4. The combine.

His investigations showed the combine to be a very successful soybean harvester.

GRAIN-SORGHUM HEADERS

Where grain sorghum is grown on a large scale for feed and for market, it is quite a laborious task to cut the heads by hand. Figure 503 shows an attachment, for a wagon, which cut the heads from the stalks and deposit them directly into the wagon box. The double pole extending to the front allows two horses to be hitched to the wagon without the neckyoke bending the stalks over and shattering large quantities of the grain.

Another grain-sorghum heading device on the market is attached to the side of the wagon box.

The combined harvester-thresher is also used to head and thresh grain sorghum.

PART IX SEED PREPARATION MACHINERY

CHAPTER XXVI

GRAIN THRESHERS

In the preparation of many crops for the market, it is necessary that the seed be separated from the stalk on which they grew. All the small-grain crops must have the seed stripped from the straw, corn must be shelled from the cob, peanuts threshed or picked from the vines, and the cotton seed separated from the lint. Different types of machines are necessary for the separation of the seed from the holding agent in the different crops. Generally, very large apparatus is necessary, incorporating a number of different operations in the same machine as the material passes through it.

531. The Grain Thresher.—The thresher is one of the largest field machines used in the processing of any of the field crops. In the true sense of the word, it is made up of a combination of several different machines having a special and separate function to perform in the separation of the grain from the straw. The modern grain thresher is a very efficient machine and when properly operated and given any reasonable care is durable and, perhaps, more nearly perfect in operation than any other machine used on the farm. It not only threshes, separates, and cleans the grain thoroughly, but accurately weighs it and delivers it into the bag, wagon box, or granary, and delivers the straw to the stack or into the barn. The whole process from the time the bundles are delivered to the feeder until the task is finished requires only about 30 seconds.

532. Functions of a Thresher.—The work performed by a thresher may be divided into six separate functions which are:

1. To feed the grain to the threshing cylinder properly.
2. To thresh the grain out of the head properly.
3. To separate the grain from the straw properly.
4. To clean the grain properly and deliver it to the weigher.
5. To weigh and record properly the amount of grain threshed.
6. To deliver the straw and chaff to the straw stack.

All parts necessary for the performance of these functions, except the fifth, are shown in Fig. 504.

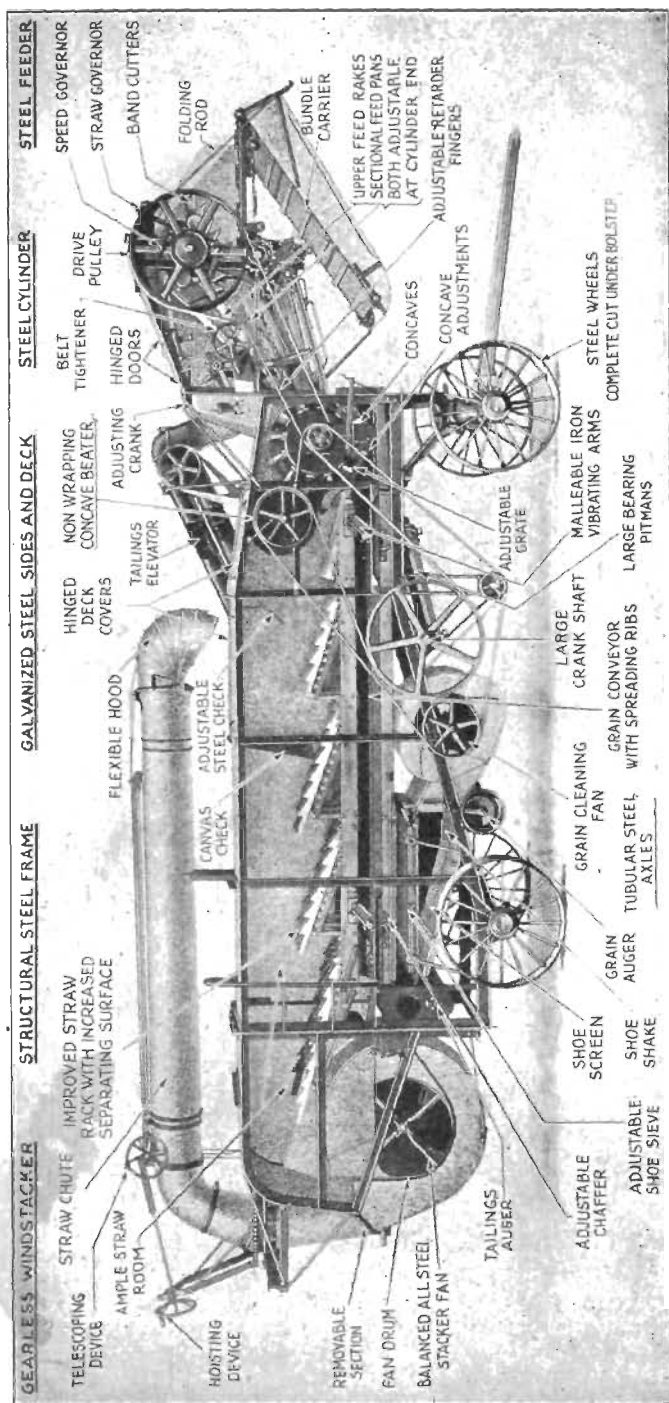


FIG. 504.—Sectional view of threshing machine showing all working parts.

FEEDING THE GRAIN

533. Self-feeder.—The feeder is a special attachment placed on the front of the machine and is shown in Fig. 505. It is the most human-like part of the whole machine, because of the peculiar manner in which it feeds the grain into the threshing apparatus, regulates the amount fed, prevents choking, and cuts the bands. The success of a threshing job depends directly upon the manner in which the bundles are pitched into the feeder and the manner of feeding. Both will have a great influence upon the grade of work done.

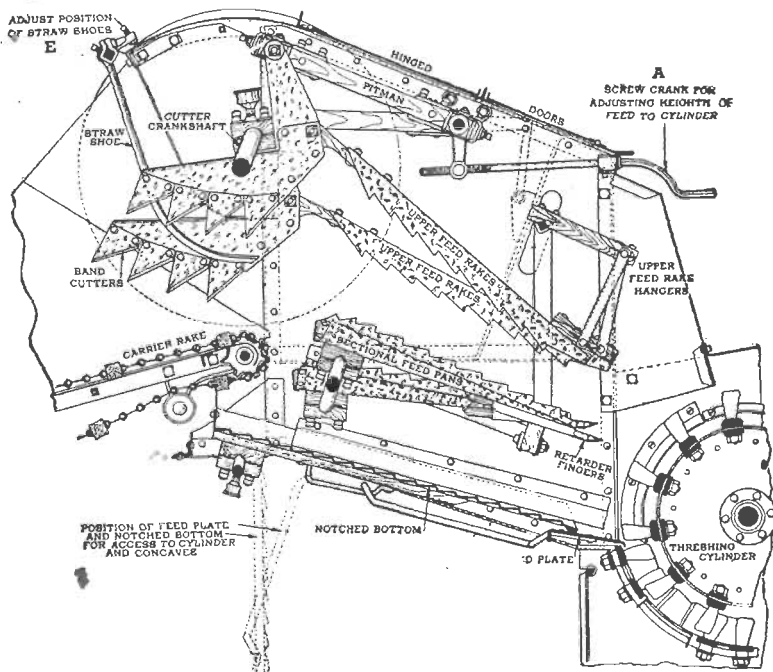


FIG. 505. Sectional view of the parts making up the self-feeder and volume governor.

The bundles should be pitched onto the feeder carrier *heads first*. If a head of straw is taken with the tip between two fingers and held closely and two other fingers strip from the tip downward, the grain will shell out easily. If the stem of the straw is held and the fingers strip over the head in the reverse direction, it is difficult to shell the kernels from the heads. This is similar to the operation and action of the cylinder and the concave teeth on the head of the grain as it passes between them. The proper manner, then, to feed the bundle into the feeder, is to place the bundle so it will be delivered to the cylinder, heads first. In the operation of a very large machine this feature is often lost sight of and the bundles pitched in and let fall any way they will.

As the carrier moves the bundles forward, they come in contact with the knives called *band-cutter knives* which cut the bands from the bundles. There are two types of band cutters, the *rotating* and the *reciprocating*. The rotating type consists of wide-curved knives placed on a shaft and revolved. The reciprocating type (Fig. 505) acts similar to the pitman on the mowing machine, because it moves up and down, to the front and back, cutting the bands and, at the same time, spreading the straw and pulling it back to the feed racks and pans.

These feed racks consist of upper feed racks and lower feed pans (Fig. 505). They feed the grain to the cylinder. The edges are notched.

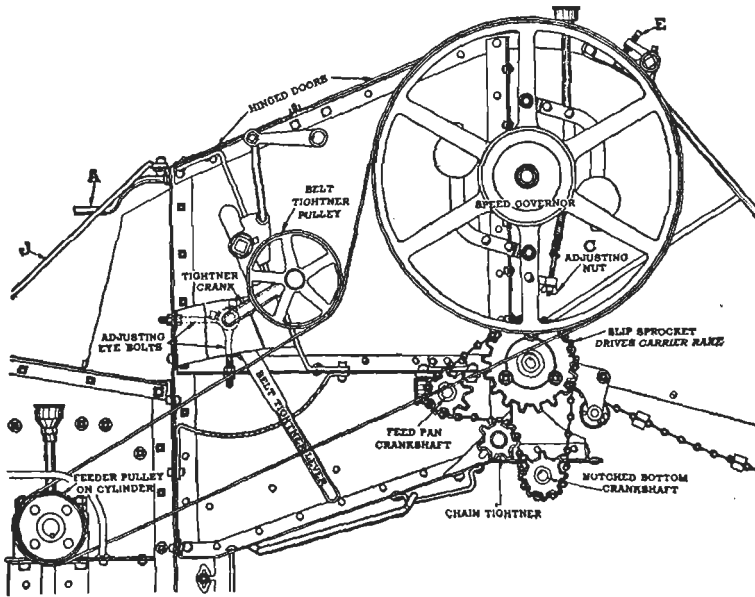


FIG. 506.- Self-feeder showing speed governor.

The racks and pans are adjustable and reciprocate back and forth to spread the straw the whole length of the cylinder towards which it is being moved.

The lower feeder pans should be adjusted so that the straw will be fed to the cylinder at a point about midway between the horizontal and perpendicular or at an angle of 45 degrees. This, of course, is for average conditions. The cylinder, if fed too low, has more suction and when fed high has a sort of combing out action.

A retarding device prevents the grain being fed too rapidly to the threshing apparatus.

534. Feeder Governors.—The action of the feeder is controlled by two governors called *speed* and *straw-volume* governors.

The speed governor is so called because it is regulated by the speed of the cylinder. The feeder does not engage until the speed of the cylinder is high enough to do good work. When threshing, if the speed of the cylinder falls below that necessary for proper threshing, the speed governor stops the whole feeder and prevents any grain being fed to the cylinder until it regains the proper speed. The sensitiveness of the governor can be regulated to suit different grains and conditions. One method of regulating the sensitiveness is shown in Fig. 506.

The straw-volume governor controls the volume of grain being fed to the cylinder and is operated by the feed pans or a special straw shoe,

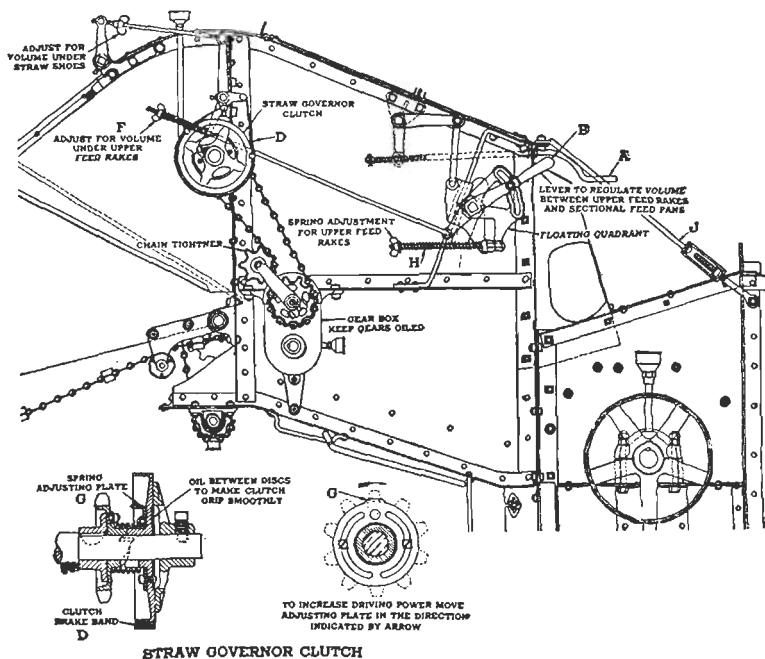


FIG. 507.—Self-feeders showing straw-volume governor.

as shown in Fig. 505. They are arranged so that an excessive volume of grain passing under them will raise them, operating a trip or brake (Fig. 507) stopping the carrier until the excess grain is fed into the cylinder. The operation of this straw-volume governor is independent of the speed governor. However, the former depends upon the latter for its power. When the volume governor stops the carrier, it does not stop the band-cutter knives and feed racks and pans. They keep on operating to feed in the excess straw.

THRESHING APPARATUS

The function of the threshing apparatus is to thresh properly the grain out of the head. The parts necessary to perform this function are

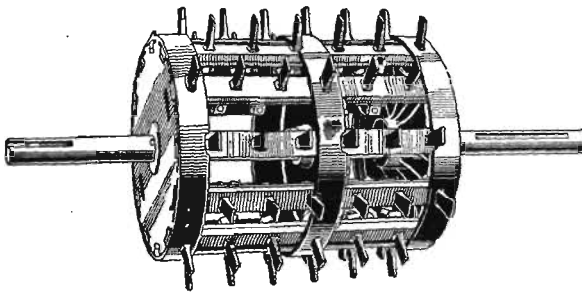


FIG. 508.—Threshing cylinder.

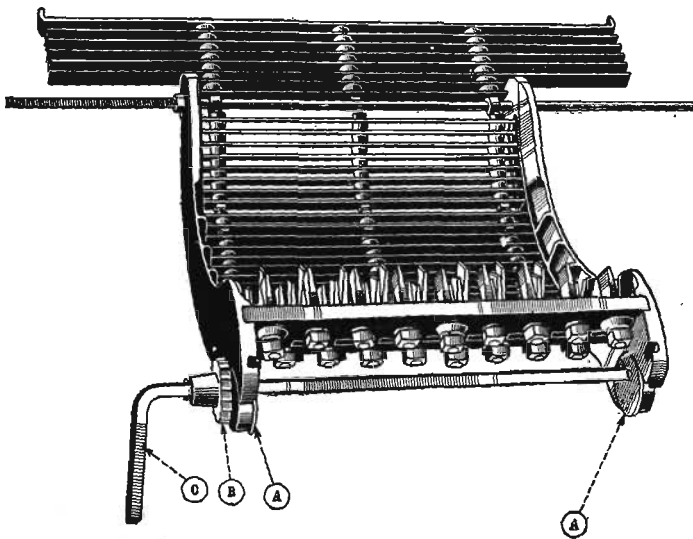


FIG. 509.—Concaves and bar grates.

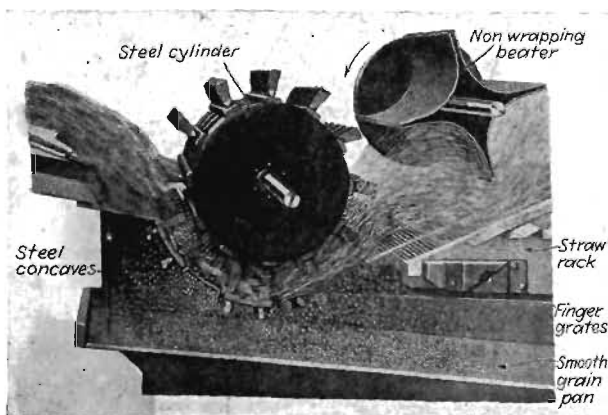


FIG. 510.—Sectional view showing functions of the cylinder, concaves, grates, and beater.

the cylinder (Fig. 508) and the concaves (Fig. 509). The position and relation of these parts to the other parts of the thresher are shown in Figs. 504 and 510. The function is accomplished by the cylinder teeth striking the grain hard enough to shatter the kernels from the head. The action is assisted by the concave teeth which project up between the cylinder teeth.

535. Cylinder and Concave Teeth.—When the cylinder and concave teeth are in proper adjustment, there should be about $\frac{5}{32}$ -inch clearance between the teeth, as shown in *A* Fig. 511. If the cylinder and concave teeth are not set close enough, unthreshed heads will pass through the space between the ends of the teeth and the bars, as shown in *B* Fig. 511. When a tooth has too little clearance on one side, and too much on the other, as shown in *C* Fig. 511, grain will be cracked and poor threshing will result.

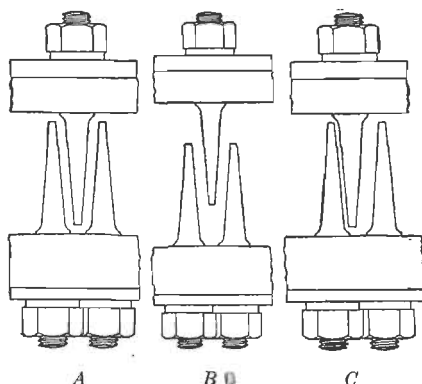


FIG. 511.—Correct and incorrect settings of cylinder and concave teeth: *A*, correct; *B*, and *C*, incorrect.

The number of rows of concave teeth can be changed for different conditions and crops.

It is essential that the cylinder teeth travel at a speed sufficient to thresh clean. The speed will depend upon the condition of the grain and the kind of crop. For the small grains, such as wheat, oats, and

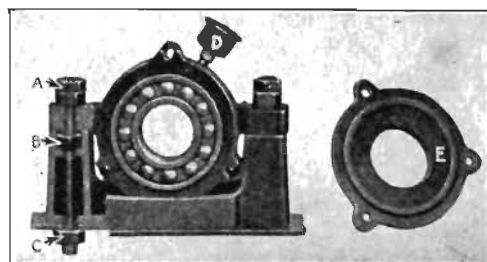


FIG. 512.—Sectional view of cylinder-shaft bearings: *A*, nuts for holding the bearing to its supporting frame; *B* and *C*, method of bolting the bearing frame to thresher; *D*, grease cup for lubricating bearing; *E*, cylinder-bearing cover.

barley, a circumferential speed at the tip of the teeth of about 6,000 feet per minute should be maintained. The size of the cylinder, which ranges from 9 to 20 bars, determines the revolutions per minute. The range of speed is from 750 to 1,400 revolutions per minute. The speed recommended by the manufacturers should be used. A speed indicator

should be used to determine the proper speed. Do not guess at the speed; know it.

536. Cylinder Bearings.—Cylinder bearings may be either babbitt, ball, or roller. Any type of bearing should be kept well lubricated. No end play should be allowed which will affect the spacing between the cylinder and concave teeth. Figure 512 shows the construction of a ball bearing for a cylinder shaft.

SEPARATING APPARATUS

The function of the separating apparatus is to separate properly the grain from the straw. The parts included in the separating apparatus are: grates, beater, straw racks, check board, curtain, and grain conveyor or pan. The location and relation of these parts to the other parts of the machine are shown in Fig. 504.

537. Grates.—The grates which are placed just below and just behind the cylinder, form a continuation of the concaves, but are considered a part of the separating apparatus, because a large percentage of the grain is separated from the straw through them.

On some of the smaller machines, the grates consist of steel tines set about $\frac{1}{2}$ inch apart, as shown in Fig. 510. In the large machines, the grates consist of parallel steel bars as shown in Fig. 509. The grates are usually adjustable and should be carried as high as possible to secure the maximum separation.

538. Beater.—The beater is mounted directly back of and close to the cylinder (Fig. 510). Its function is to prevent the straw from following and winding around the cylinder. It also directs the grain and straw down upon the straw racks, retards its velocity, and aids in separating the grain from the straw.

539. Check Board.—A check board (Fig. 504), made of wood or steel hinged at the upper edge, is placed just to the rear of the beater. It prevents the cylinder and beater from throwing grain or straw to the rear of the machine.

A canvas curtain (Fig. 504) is placed near the center of the machine to retard the straw as it passes over the straw racks.

540. Straw Racks.—Figure 504 shows the location of the straw racks. They extend the whole length of the machine from the grates to the wind stacker. The function of the straw racks is to remove all loose grain from the straw as it is agitated and conveyed to the rear of the machine and dropped into the wind-stacker fan housing.

The straw racks are provided with four or five risers with *fish backs* to toss and drop the straw as it is worked backward to the rear of the machine. The loose grain falls through the spaces in the straw racks to the grain pan below.

The average speed for the rack shafts ranges around 230 revolutions per minute. When driven at this rate of speed, the straw that is pitched up on the upward movement of the straw rack falls back onto the rack at about the same time that it is ready to start on another upward movement. If operated at a faster speed than this, the straw rack will likely start on another upward movement before the straw has had time to drop back on the rack and prevent the steady movement of the straw to the rear.

541. Grain Pan or Conveyor.—The grain pan extends from the front of the machine to the cleaning shoe. The chaffer joins and forms a continuation of the grain pan (Fig. 513).

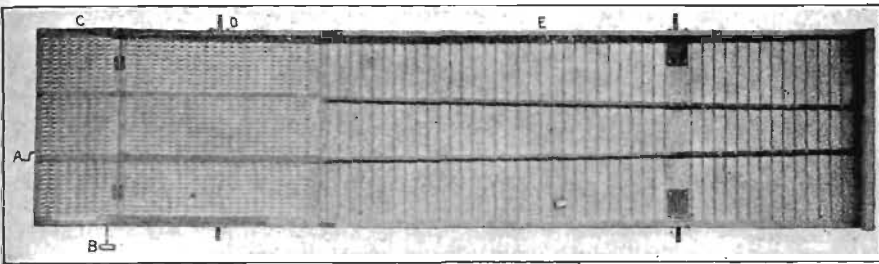


FIG. 513.—Grain pan with chaffer and chaffer extension: A, adjustment for chaffer extension; B, adjustment for chaffer; C, chaffer extension; D, chaffer; E, grain pan.

All the grain that is shattered by the feeder, threshed, and separated by the cylinder concaves, grates, beater, and straw racks, falls upon the grain pan, located underneath them. The grain is conveyed backward by an oscillating motion to the cleaning shoe.

CLEANING APPARATUS

The function of the cleaning apparatus is to clean the grain properly and deliver it to the weigher. It is accomplished by passing the

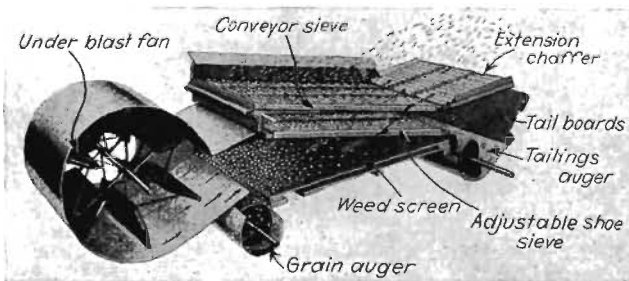


FIG. 514.—Cleaning apparatus.

uncleaned grain over a series of sieves and screens, through which a current of air is forced, as shown in Fig. 514.

The parts necessary to perform this function include: shoe, chaffer, chaffer extension, sieves, screens, tailings elevator, and fan.

542. Shoe.—The combination of the sieves and the screen used for cleaning the grain is commonly called the *shoe* (Fig. 514).

543. Chaffer.—The chaffer or conveyor sieve forms a continuation of the grain pan (Fig. 514). Part of the coarser straw and some chaff are retained on the chaffer, as they pass over it, while the grain drops through upon the shoe sieve. The size of the openings in the chaffer is adjustable to suit different kinds of grain.

544. Chaffer Extension.—The chaffer extension is a continuation of the chaffer (Fig. 514). It has larger openings and is set at a steeper angle, to allow the unthreshed heads to drop through into the tailings auger trough.

545. Tailings Auger and Elevator.—The unthreshed heads and grain that work back without falling through the chaffer are called *tailings*. They fall through the open spaces of the chaffer extension into the tailings auger trough and are conveyed out to the side by an auger and delivered to an elevator which carries them back to the cylinder for a second threshing. The kind and quantity of tailings are an indication of the grade of work being done by the thresher. If all parts of the machine are properly set, very little tailings will be had.

546. Sieves.—Sieves may be adjustable or non-adjustable. The adjustable type is used more often in modern threshers. It is essential to have the proper opening suited to the type of grain being threshed. The opening should be just large enough to permit the free passage of the clean grain.

547. Screens.—It is sometimes necessary to place a screen in the bottom of the shoe to remove weed seeds and other foreign material. The screened out material is allowed to fall on the ground. The grain gravitates down the bottom of the shoe to the grain auger trough where it is carried out by the grain auger.

548. Fan.—Figure 514 shows the location of the fan. It creates a blast of air which should be just strong enough to lift out the chaff and other light material. The blast is regulated by *fan blinds*, on each end of the fan housing. If a stronger blast is desired, the blinds should be opened. If the blast appears to be too strong on one side, the blinds on the opposite side should be closed a little.

549. Grain Handlers.—To weigh and record properly the amount of grain threshed, grain handlers are placed on the threshing machine to receive the fresh grain from the grain auger, elevate it, and deliver it to the loader or weigher. Loaders are nothing more than elevators with spouts for delivering the grain to the wagon or bagging attachment (Fig. 515). When a weighing attachment is used, it has an elevator with

a weighing and recording mechanism. In general, the various parts composing a weigher will consist of the following: hopper, scale beam, ship bracket, trip pin, trip dog, gear shaft, driving gear, elevator cut-off, hopper cut-off, and recorder. The weigher (Fig. 516) is a mechanism

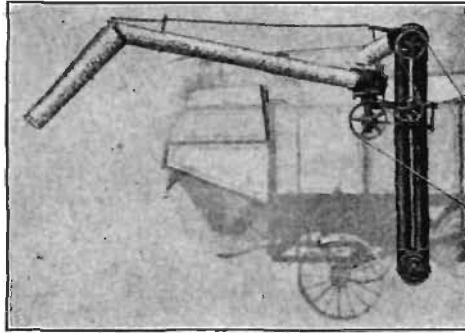


FIG. 515.—Grain loader.

which automatically weighs a quantity of grain and, then, automatically dumps it into a spout for bagging or directs it to the wagon. At the time the grain is dumped, it operates the registering device or recorder which registers by half bushels, the number of bushels threshed.

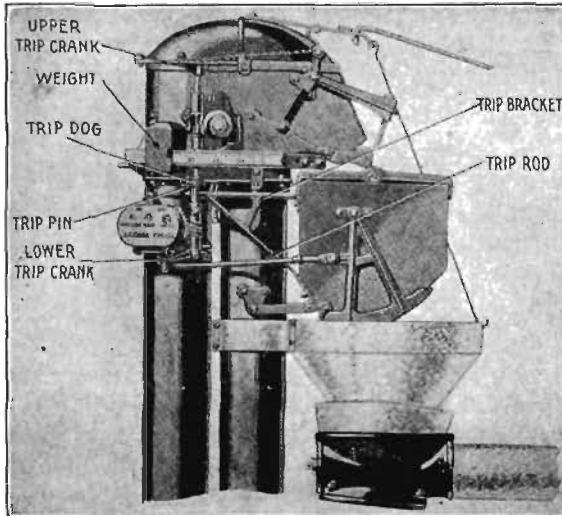


FIG. 516.—Grain weigher.

550. Strawstacker.—The function of the strawstacker is to deliver properly the straw and chaff to the strawstack by means of the wind stacker (Fig. 517). The wind stacker is being used almost universally and is very simple and compact in construction. The straw can be

delivered to almost any place desired without the aid of men to do the stacking. It is often desirable to deliver the straw directly into the barn. The wind stacker is able to do this very well. There is a large fan case in which is located a good sized fan that receives and blows the straw out through a tube-like chute. This fan should be driven at a speed to insure a blast strong enough to care for any volume of straw. Most wind stackers are provided with a turret which will cause the chute to

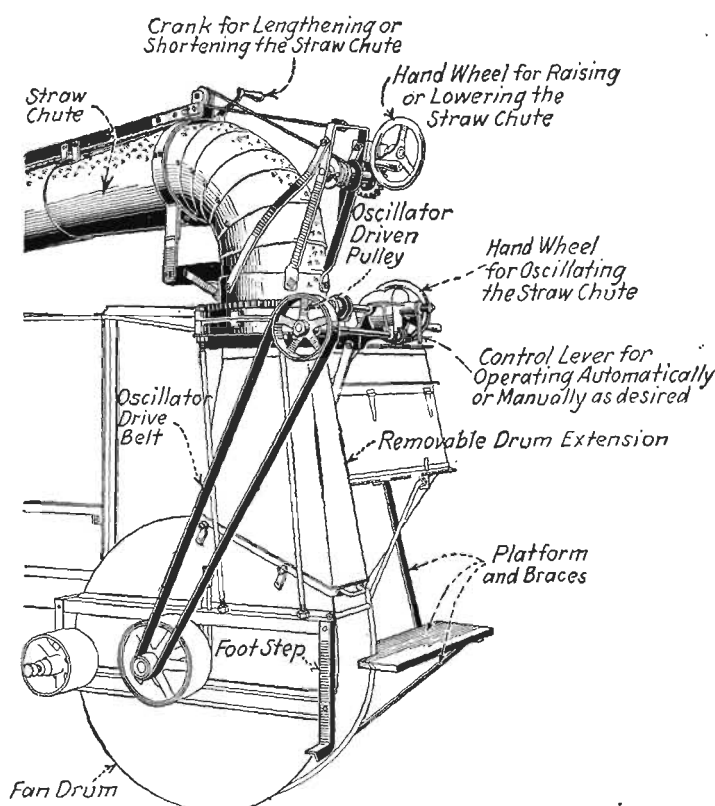


FIG. 517.—Wind stacker and straw chute.

oscillate so that the straw will be delivered over a large space. When the chute has traveled in one direction some distance, an automatic trip pin causes it to reverse its motion and swing in the opposite direction. Stackers are sometimes provided with a *grain-saving attachment*. Lattice-work or a grate is placed in the bottom of the fan case which allows the grain to drop from the straw. A small auger operating in a pipe will convey the grain saved to the tailings auger.

551. Size of Threshing Machine.—To determine the size of a threshing machine, two measurements must be taken: the width of the throat

or the width of the cylinder and the width of the machine at the rear. These measurements will give the size of the machine. For a very small thresher, the width of the cylinder is 20 inches; the rear of the machine is 28 inches; then, the machine is a 20- by 28-inch thresher—this is about the smallest machine built. Large types of thresher may have a width at the cylinder of 40 inches and a width at the rear of 62 inches—making a 40- by 62-inch machine.

552. Setting a Thresher.—Many threshing-machine operators do not pay as much attention to the setting of the threshing machine before starting work as they should. Many times they just swing the thresher around in position, dig under the wheel that seems to be high to bring it down to what seems to be a proper level, bring the tractor up, put on the drive belt, and go ahead. Of course, the grain can be threshed when no care at all is taken in setting, but the amount of grain that is secured is materially decreased.

To set a threshing machine properly, an ordinary carpenter's level should be used to see that the machine is level both lengthwise and crosswise. The level should be put on some part of the frame which is rigid so that there will be no mistake in getting it level. When set level, the sieves and screens can be given the proper inclination for good cleaning. If the machine is lower in front than in the rear, the grain, chaff, and straw may be retarded, causing the conveyor to choke.

Under some conditions, a thresher will do slightly better work if set lower at the rear than at the front, but most threshers will operate best when setting level. If the thresher is not setting level crosswise, the grain may overload the sieve on the side which is lower and the other side be practically clear. When such conditions prevail, it is difficult to adjust the sieve to do a good cleaning and separating job.

In the setting of any machine, the direction of the prevailing wind should be considered. Generally, it is best to set a thresher quartering with the wind than it is to set it in direct line. This is especially true when steam tractors are used. It reduces the danger of fire from sparks of the engine; then, too, the men do not have so much dirt to work in. It will also help in the feeding.

553. Fire.—In case of fire, quick work must be done to prevent the loss of the machine. The quickest way of pulling the separator away from the straw stack is to pull it out by the belt, having a man get at each wheel of the thresher to help start it. A better method is to have a rope attached to the separator and to the tractor, ready in case of an emergency. When this is done, the belt can be slipped off and the thresher drawn out with the rope, eliminating any danger of injuring the belt.

554. Recleaners.—Where there is much foreign grass seed or other dockage, it is desirable to reclean the seed before marketing. One type

of cleaner consists of a number of sieves and screens through which the grain is run, being entirely separate from the screens and sieves of the thresher proper. The latest type of recleaning machinery is made of aluminum disks, as shown in Fig. 518. Both sides of these disks contain small undercut pockets and, when set up, the disks are mounted $2\frac{3}{4}$ inches apart on a shaft which rotates about 60 revolutions per minute. As it rotates through the grain, the wheat is picked up by the pockets and deposited separate from the grass seed.

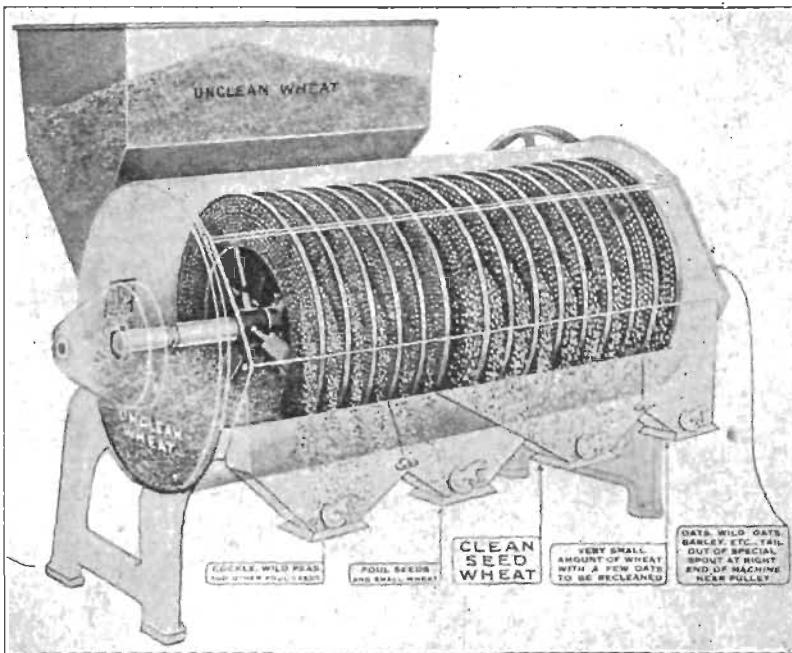


FIG. 518.—Disk recleaner.

555. Cost of Threshing. The cost of threshing is compared with other methods of harvesting in Table XIX. The cost for threshing is figured at 10 cents per bushel for a 15-bushel yield.

There are four methods of threshing from which to choose: hire the custom thresherman, belong to a large cooperatively owned threshing ring, be a member of a small ring, or be an owner operator. The choice of the method often depends upon the location of the section and the prevailing rates.

556. Capacity of Threshers.—There are so many variable factors which will affect the rate of threshing, that no definite figures can be given for the different sizes of threshers. Some of the factors involved are: kind of grain, condition of grain, yield of grain, condition of machine, power available, rate of feeding, wastage of grain, and the general design

of the machine. One company, with reservations, gives the approximate capacity of the various sizes of machines that it manufactures as shown in the following table:

TABLE XVIII.—CAPACITY FOR WHEAT AND OATS PER HOUR OF VARIOUS SIZES OF THRESHER

Size of thresher	Bushel per hour	
	Wheat	Oats
20 by 28	30 to 50	60 to 90
22 by 36	60 to 90	100 to 175
28 by 46	80 to 125	150 to 225
28 by 50	90 to 140	175 to 260
32 by 54	100 to 150	190 to 300
36 by 58	120 to 175	220 to 340
40 by 62	155 to 210	250 to 400

557. The Grain-shock Sweep. Figure 519 shows a sweep rake especially designed to handle shocks of grain. It is mounted on the front of a tractor and equipped with a high back and sides to keep the bundles from sliding off the long rake teeth. In loading the sweep the long teeth slide under the shocks without much agitation, and, therefore, not much grain is lost. After the sweep is loaded the teeth are raised with a power lift.

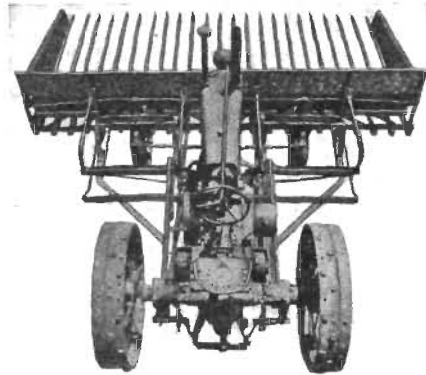


FIG. 519.—Grain-shock sweep rake that will carry from five to eight shocks to a load.

PEANUT THRESHERS AND PICKERS

The method of gathering the peanuts from the vine after they have been dug and cured is a very slow and tiresome process unless improved machinery is used. The old primitive way of gathering them from the vine was by picking them by hand. The average picker, when picking by hand, can pick only about 8 to 12 bushels per day. With the scarcity of labor and the improvement of peanut-picking machinery, hand picking has been displaced by improved machinery in the peanut-growing sections. There are two types of machines used for removing peanuts from the vines: the thresher and the picker.

558. Peanut Thresher.—The peanut thresher is a cylinder type of machine similar to the regular grain thresher in all respects with the exception of size and a few other minor changes. The vines are fed

into the cylinder and the cylinder teeth jerk the vines between the concave teeth, thus threshing the pods of peanuts from the vines. The vines are then carried back over the straw racks where they are sifted and drawn back into the stacking apparatus. One objection to this type of machine is the tendency to break the pods, shelling out and injuring the peanut. It is necessary to run the cylinder rather slowly to overcome this tendency. Around 400 revolutions per minute is the average speed.

559. The Peanut Picker.—The other type of picking machine differs materially in principle from the cylinder machine and is shown in Fig. 520. The picking is done by dragging the vines over wire mesh screen

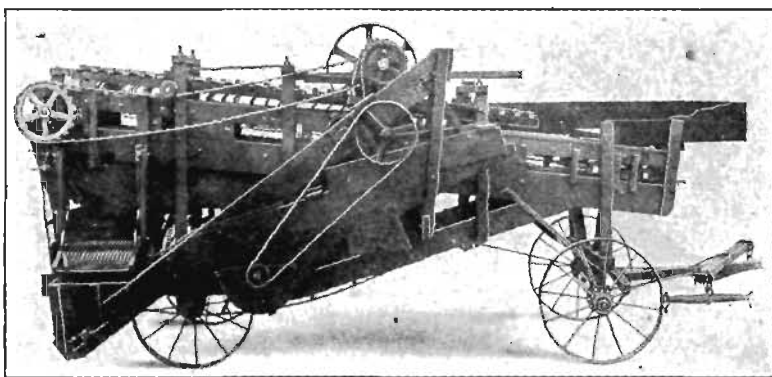


FIG. 520.—Peanut picker equipped with recleaner and bagging attachment.

in such a way that the nuts fall through and are brushed off from the lower side. There is practically no tendency to break and injure the pods. Very little power is required for operation since the 5- or 6-horsepower gasoline engine is sufficient. These machines are easily provided with attachments for cleaning and removing the small stems from the pods and turning out a better grade of nuts. The capacity of this type of machine depends upon the design and the condition of the peanuts, about 250 bushels per day being an average.

THRESHING COWPEAS

When it is desired to harvest cowpeas or field peas in large quantities for seed, it is necessary to remove the peas from the hulls either by beating or by flailing or by running them through some type of thresher. If they are to be threshed by being spread on the ground and beaten out, and the hulls then separated from the peas, it is a very slow, tedious, and dirty process. A better method is to use an ordinary grain thresher, running the cylinder at a comparatively low speed.

There are small cowpea hulling machines that can be secured. Where the small farmer desires to harvest and save his own seed, a machine

can be obtained at a fairly low price and is of great help. It also can be used for hulling beans and other similar crops.

THRESHING VELVET BEANS

The velvet bean produces very long vines covering corn stalks or such things completely, forming a matted mass. It is next to impossible to cut this crop with a mowing machine and harvest it like any other hay crop. It is usually left in the field and the stock turned in to do the harvesting. But some means must be provided to secure a sufficient quantity of seed for each year's planting. The beans must be picked from the vines by hand. They, then, must be shelled. The hull is very hard and thick and a special type of machine is necessary for bursting the hull open, allowing the beans to fall free.

CHAPTER XXVII

COMBINED HARVESTER-THRESHER

The combined harvester-thresher or *combine* heads the standing grain, threshes, and cleans it as it moves over the field. It, therefore, takes the place of and eliminates from the harvest the grain binder, the header, the stationary thresher, and the tiresome task of shocking or stacking the grain, and hauling of the bundles.

The combine is adapted to harvesting all the small grains, soybeans, grain sorghums, and has been tried out in rice with some success.

560. Types.—There are two general types of combines, the *prairie* and the *hillside*.



FIG. 521. Combined harvester-thresher.

The prairie-type combine may be ground driven and pulled by horses; it may have an auxiliary engine and be pulled by either horses or tractor, as shown in Fig. 521; and it may be drawn by a tractor with a direct power drive from the tractor.

The hillside-type combine has a leveling device so the machine can be used on sides of hills. It is also equipped with an auxiliary engine.

561. Sizes.—The size of a combine is governed by the length of the cutter bar. This is ordinarily 7, 8, 9, 10, 12, 15, 16, and 20 feet long. A few machines are used with 24- and 35-foot cutter bars. Table XX, page 349, shows that the more common sizes are 12- 15-, and 16-foot machines. "Baby" combines of 5- and 6-foot cuts are now available.

Extensions for the cutter bars are used where it is desired to increase the size.

The power required to draw the different size combines over the field varies with the size of the machine. The 9- and 10-foot power take-off combines require tractors with 15-drawbar horsepower. The same size machines equipped with an auxiliary engine require about six horses, or tractors with 9- to 12-drawbar horsepower. The 20-foot sizes require tractors with 20-drawbar horsepower.¹

CUTTING UNIT

The part of the combine that does the cutting or harvesting is frequently referred to as the *header*. It does not greatly differ from the

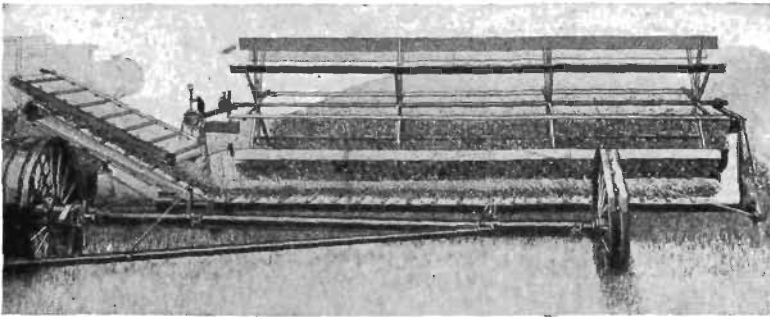


FIG. 522.—Platform of combine showing action of parts on grain.

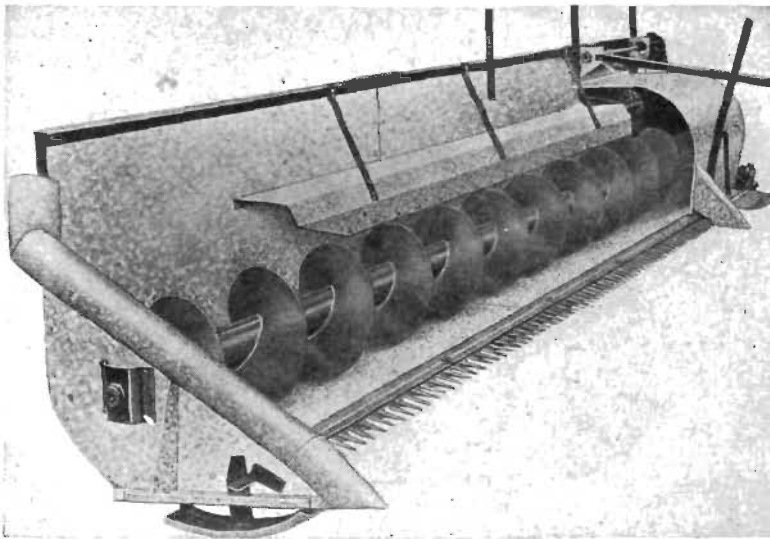


FIG. 523.—Auger conveyor for combine platform.

cutting unit of the binder or header except that it must be built stronger, be adjustable for height, and deliver the cut grain direct to the threshing unit.

¹ U. S. Dept. Agr. *Farmers' Bull.* 1565, p. 5, 1928.

562. Platform.—The header platform is supported about midway between the front and main thresher wheels by balancing it over the main axle by beams and weights and springs. Figure 524 shows one method of balancing the header platform. The weight of the platform is counterbalanced by the weight of the thresher. No weights or springs are used.

The platform can be lowered to within 2 or 3 inches of the ground and raised to cut 4 feet or more above the ground. When moving the machine, the platform

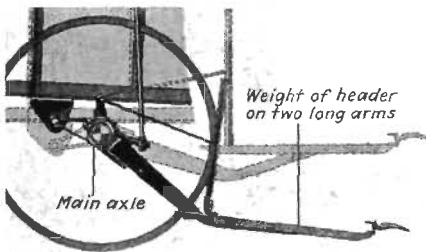


FIG. 524.—Method of balancing platform. The weight of the thresher counterbalances the weight of the platform.

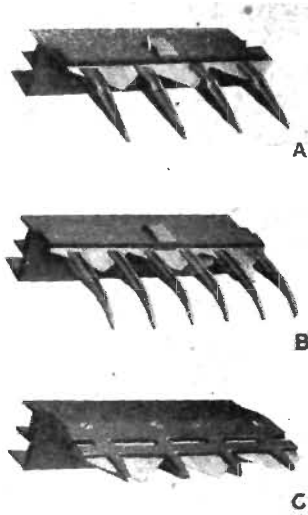


FIG. 525.—Types of cutter bars for combines: A, standard-type sickle bar, three-inch center; B, the two-inch center-type sickle bar; C, trash-type sickle bar.

is usually disconnected and carried behind or beside the machine on transport wheels.

563. Cutter Bar.—The cutter-bar parts of a combine are the same as those for a header (Fig. 525). Wood or steel pitmans are used to connect the crank shaft and the sickle.

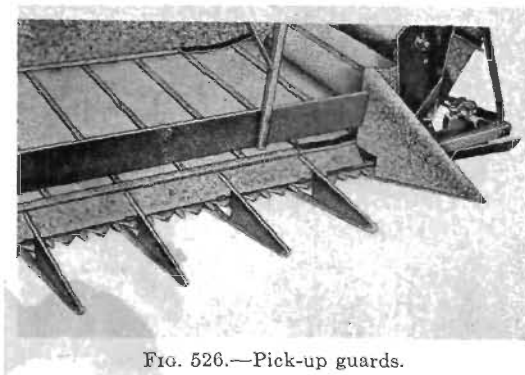


FIG. 526.—Pick-up guards.

Where the grain has fallen down, special grain-saving guards will pick up and save a large percentage of the grain that otherwise would be lost (Fig. 526).

564. Canvas.—One canvas or *draper* running close to the sickle carries the grain directly into the feeder house. A top elevator canvas is used on the elevating section to prevent the grain blowing out and to assure positive and uniform feeding (Fig. 527).

565. Reel.—The reel consists of a number of wide wooden slats well supported by reel arms. It is driven by shafts and gears. A snap clutch

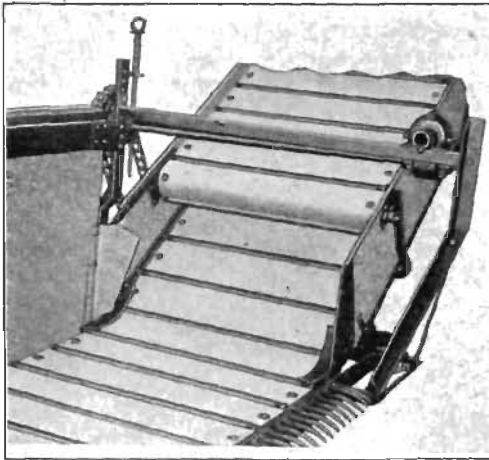


FIG. 527.—Section of cutter bar, platform canvas, and elevator canvas.

prevents breakage of reel and driving parts. A hinged slat is now used on some machines.

THRESHING UNIT

The threshing unit of the combined harvester-thresher performs its work very much like a regular stationary thresher. The various functions performed are: feeding, threshing, separating, cleaning, elevating grain to the cleaning device and then to a grain tank or wagon, and spreading or dumping the straw on the ground behind the machine. Figure 528 shows a cross-sectional view of a combine threshing unit.

566. Feeder House.—From the platform the grain is delivered to the feeder house, heads first. The grain is conveyed to the threshing cylinder by an endless carrier. The wooden slats of the carrier slide on the smooth surface of the sheet-metal bottom of the feeder house and positively convey all grain, chaff, and straw to the cylinder. A beater just in front of the cylinder assists the feeder carrier in feeding the grain to the cylinder (Fig. 528).

567. Cylinder and Concaves.—The cylinder and concaves are constructed much the same as a thresher. Most machines use teeth on the cylinder and concaves but at least two machines use the *rasp-bar* type (Fig. 529). The cylinder bearings are either ball or roller. The

concaves can be adjusted both sidewise and up and down from outside the machine.

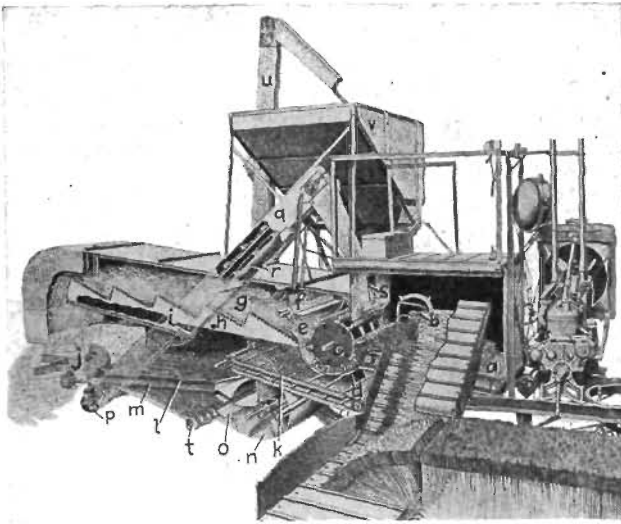


FIG. 528.—Sectional view of combine showing path of grain through machine.

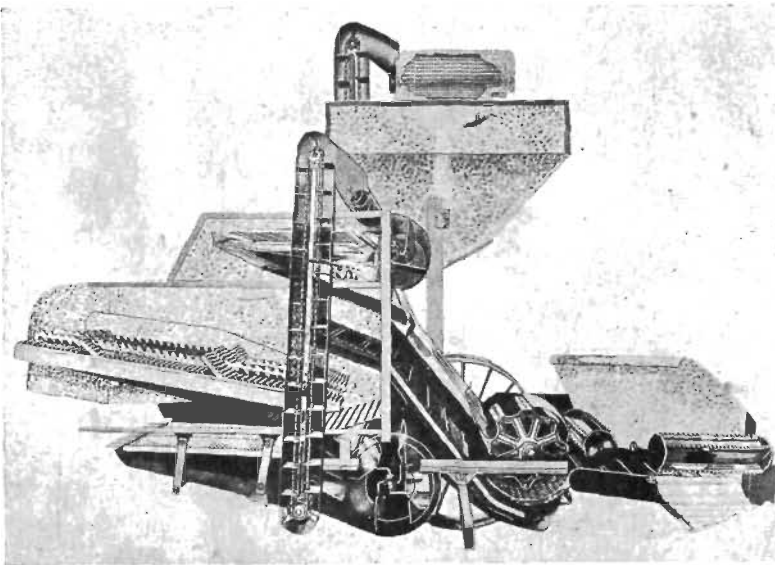


FIG. 529.—Sectional view of combine equipped with rasp-bar cylinder and concaves. Note weed screen at top.

568. Separating Apparatus.—The usual grates, beaters, and check boards are used in the combine separating apparatus. There are two methods of conveying the straw through combines.

One method uses straw racks. These racks may be in one or four sections. Where four sections are used, as shown in Fig. 531, they agitate and kick the straw backward by being mounted on a four-throw crank shaft at the rear and rocker arm at the front.

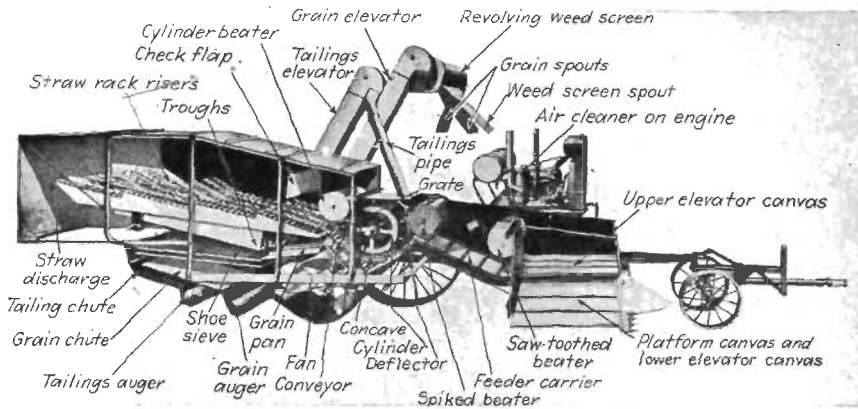


FIG. 530.—Cross-section of combine with all parts named.

Another method makes use of carriers; usually two. One is located just back of the cylinder and may be termed the *front* or *grain* carrier, while the other is in the rear part of the machine and is termed the *rear* or *straw* carrier.

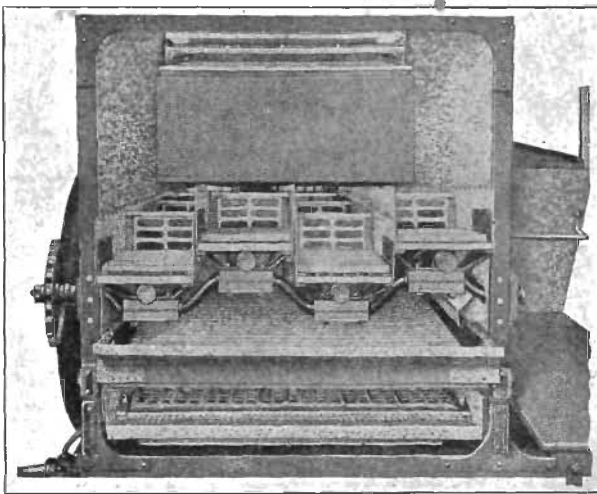


FIG. 531.—Rear view of straw racks and grain pan.

As the straw passes from the front to the rear carrier, it comes in contact with three or four beaters which tear it up and aid in the separation of the grain from the straw and chaff.

From the beaters the straw falls on the rear carrier and is conveyed out of the machine. If straw racks are used, the straw is delivered

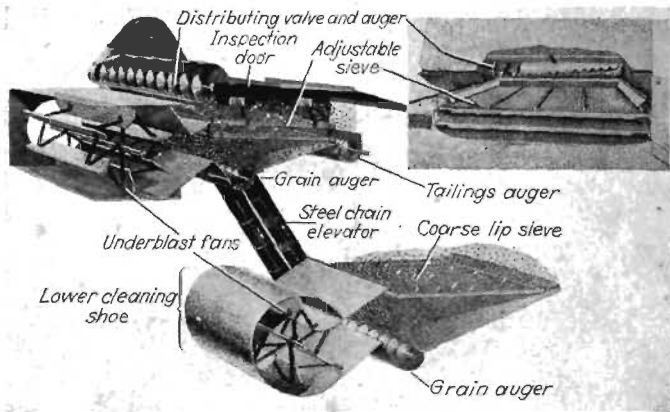


FIG. 532.—Separator shoe and recleaner.

directly to them from the cylinder and beater. The straw is then kicked back through the machine. The grain falls upon a grain pan underneath the straw racks and is carried back and delivered into the separating shoe—thence to the recleaner.

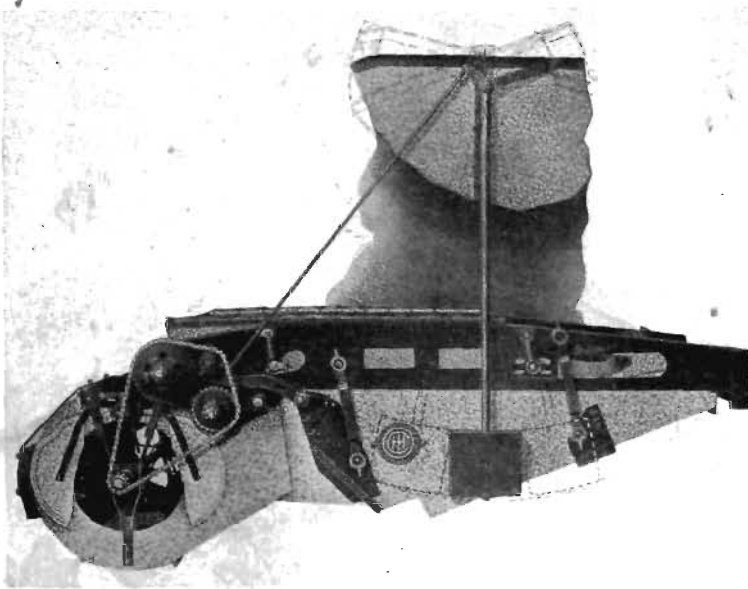


FIG. 533.—Self-leveling device for combine.

569. Separator Shoe.—The grain with some chaff falls upon a grain pan and into the separator shoe. In the shoe is a fan which directs a

blast of air through the grain as it falls upon and passes through a sieve, clearing out some chaff.

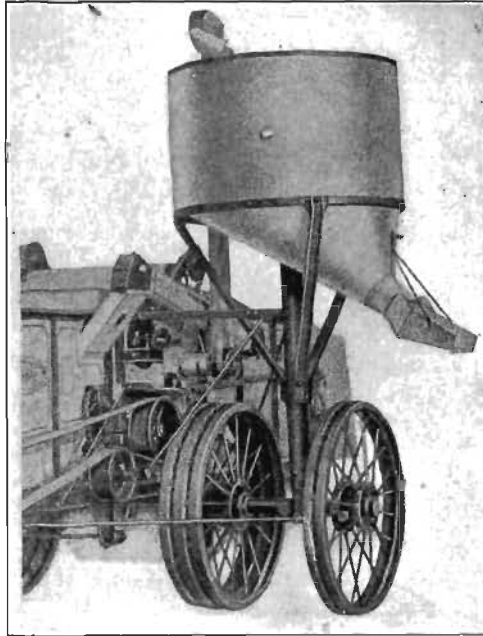


FIG. 534. Grain tank mounted on combine.

The grain then gravitates into an auger which carries it outside the machine into an elevator which, in turn, elevates it up to the recleaner located above the separating apparatus (Fig. 532). Any tailings that may result are returned by the tailings elevator to the feeder house.

570. The Recleaner.—A special distributor auger spreads the grain over the recleaner sieves. A recleaner fan directs a blast of air up through the grain as it passes through the sieve, removing the chaff. The cleaned grain falls upon the inclined shoe bottom and slides down into an auger trough where an auger delivers it to a second elevator which elevates it into the grain tank (Fig. 534) or conveys it to a wagon drawn beside the machine.

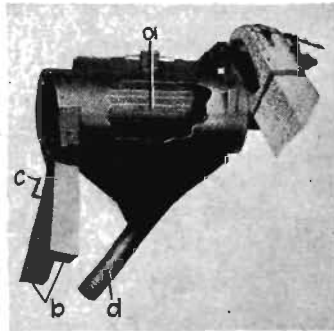


FIG. 535.—Revolving weed screen.

571. Weed Screen.—Where weeds have grown up and gone to seed by harvest time, it is essential that the weed seeds be removed from the grain. Figure 535 shows a weed screen used on a combine. This machine consists of a revolving drum with elongated

holes large enough to permit small weed seeds to fall through but not the grain. Other machines are equipped with disk cleaners.

572. Grain Weigher.—Some machines are equipped with a grain weigher to weigh and record the number of bushels threshed. The weigher receives the grain from the elevator.

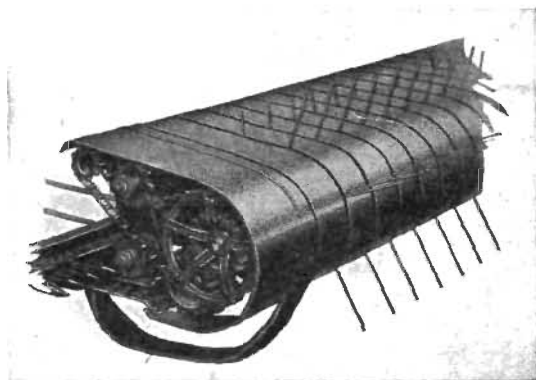


FIG. 536.—End view of the pick-up attachment, showing the drive mechanism exposed.

573. Straw Spreaders.—As the straw passes from the straw racks or straw carrier it may fall directly on the ground in a windrow or onto a straw spreader (Fig. 528) which scatters it on the ground behind the combine.

574. Auxiliary Engine.—To operate both the header unit and the threshing unit, an auxiliary engine of ample power should be mounted



FIG. 537.—Small power take-off driven combine harvesting soybeans. Note the combine is equipped with rubber tires.

on the machine. A few small machines, however, receive their power direct from the tractor engine.

An auxiliary engine is mounted either to the front of the machine (Fig. 528) and the power transmitted to the cylinder by belt, or it is placed on the side of the machine over or near the main axle. With the

latter arrangement, the engine may be so placed that the crank shaft of the engine and the cylinder shaft are connected by means of a clutch. Such a connection is not always possible and the power is transmitted to

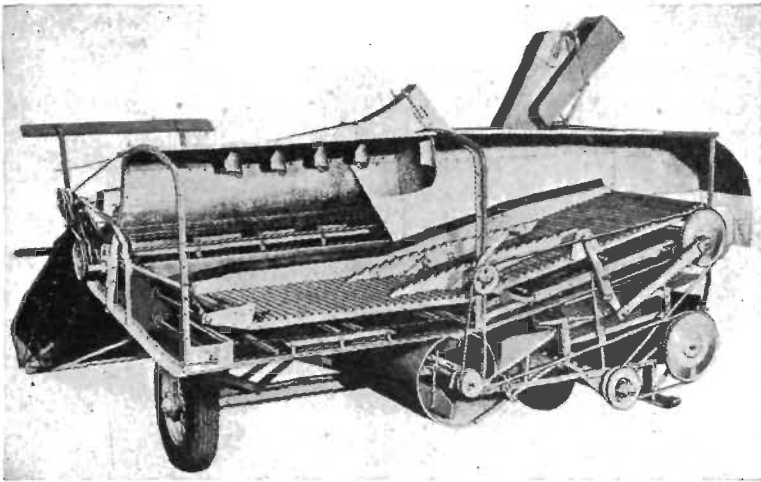


FIG. 538.—Sectional view of combine shown in Fig. 537. Note construction of cylinder and the use of V-belts.

the cylinder shaft by high-speed chains or belt. The engine is equipped with a governor which can be adjusted to give the proper speed.

575. Windrow Pick-up.—In sections where grain does not ripen uniformly the grain is cut and windrowed, then left until the moisture content of the grain is low enough to prevent damage in storage. Figure 536 shows a section of a typical windrow pick-up attachment.

576. Special-crop Attachments.—Special attachments are available for combines so that a number of special crops can be harvested with this type of machine. Crops that can be harvested are soybeans, peas, beans, flax, clover, alfalfa, lespedeza, and grain sorghums.

The "baby" combine, similar to the one shown in Figs. 537 and 538, is recommended for soybeans and other crops. Hurst¹ lists several features essential for combines to successfully harvest soybeans. They are:

a narrow cut of 5 or 6 feet, threshing cylinder designed to handle large masses of straw and vines, low cut within 2 inches of the ground,

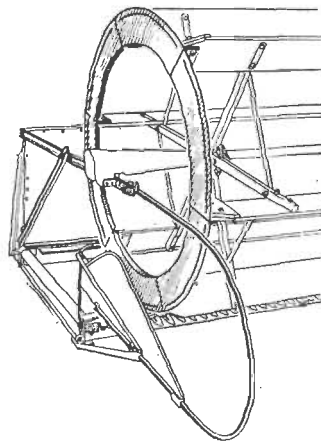


FIG. 539.—Reel hoop and outside divider rod to divide tangled vines and prevent winding on reel shaft.

¹ *Agr. Eng.*, Vol. 16, No. 6, p. 223, 1935.

gentle reel action, over-all width of machine not to exceed 12 feet, weight of from 2,500 to 3,000 pounds, cost not to exceed \$500, suitable for other crops, driven by power take-off of tractor, quick and easy adjustments, and flexible mountings of pneumatic tires or springs.

It has been found that a reel hoop and special dividers are necessary in harvesting soybeans (Fig. 539).

577. Advantages of the Combine.—In comparison with other methods of harvesting and threshing, as reported by farmers, the advantages are:¹

1. The saving in harvesting and threshing costs.
2. The decreased labor.
3. The elimination of hired help.
4. The earlier clearing of the field for tillage operations.
5. The distribution of the straw on the land.
6. The earlier marketing of the crop.

578. Disadvantages of the Combine.—The disadvantages of the combine enumerated are:

1. The large investment necessary.
2. The large amount of power required.
3. The grain is more likely to be damp.
4. Greater risk to crops from storms and hail.
5. The loss of straw for feed and bedding unless additional labor is expended in collecting the straw after the combine.

579. Cost of Combining.—The various items of cost in harvesting with a combine are operating and fixed costs.

Operating expenses consist of the costs of fuel and lubricants, use of tractor, labor, and repairs.

Fixed charges are for depreciation and interest on investment.

Taxes, insurance, and cost of housing may also be added.

Table XIX shows the various items of cost per acre for both operating expenses and fixed costs; for a 10- and 15-foot combine, a 7-foot binder, and a 12-foot header.

With an assumed yield of 15 bushels per acre, this would be equivalent to an average of approximately 10 cents per bushel with the combine, 22 cents per bushel with the header, and 28 cents per bushel with the binder.

If depreciation, interest on investment, and insurance were added, the cost per bushel for the different methods would be, approximately, 14, 23, and 29 cents, respectively.

The graph shown in Fig. 540 gives a comparison of the harvesting costs for combines, headers, and binders. Figure 540A is based on Table XIX. Figure 540B shows the estimate of immediate costs

¹ U. S. Dept. Agr. Farmers' Bull. 1565, 1928.

for different machines with no allowance made for unpaid labor, power or interest on the investment.

TABLE XIX.—CHARGES PER ACRE WITH DIFFERENT HARVESTING METHODS⁸

Item of cost	Per acre charges							
	10-foot combine		15-foot combine		7-foot binder		12-foot header	
	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
Man labor, ¹ man hours	0.69	\$0.41	0.65	\$0.39	3.6	\$1.80	2.8	\$1.40
Horse labor, ² horse hours	.....	.....	.....	.....	5.9	0.59	4.1	0.41
Tractor	.....	0.60	.....	0.60	.....	.....	.....	.....
Fuel ³ gallon	1.30	0.32	1.43	0.36	.....	.....	.....	.....
Oil ³ gallons	0.04	0.03	0.05	0.04	.....	.....	.....	.....
Grease, pounds	0.06	0.01	0.05	0.01	.....	.....	.....	.....
Twine, ⁴ pounds	.....	.....	.....	.....	2.0	0.28	.....	.....
Repairs	.....	0.10	.....	0.10	.....	0.05	.....	0.05
Threshing ⁵	.....	.....	.....	.....	.....	1.50	.....	1.50
Variable costs	.....	\$1.47	.....	\$1.50	.....	\$4.22	.....	\$3.36
Annual charges								
Depreciation ⁶	.....	\$152.00	.....	\$251.00	.....	\$22.50	.....	\$13.33
Interest ⁷	.....	37.80	.....	62.52	.....	6.75	.....	6.00

¹ Labor on combines charged at 60 cents per hour; on binder and headers at 50 cents per hour.

² Horse labor charged at 10 cents per hour.

³ Fuel charged at 25 cents, oil at 75 cents per gallon.

⁴ Twine charged at 14 cents per pound.

⁵ Threshing charged at 10 cents per bushel; 15-bushel yield assumed.

⁶ Based on 8.3 years life for combine, 10 years for binder, 15 years for header.

⁷ Annual charge per machine based on one-half the first cost at 6 per cent.

⁸ U. S. Dept. Agr. Tech. Bull. 70, p. 31, 1928.

580. Acres Cut by Combines.—Most people think of the capacity of a machine as the amount of work it can do in a day's time. The principal factors that influence the rate of cutting are: the size of the machine, rate of travel, and yield of grain.

Reynoldson Kifer, Martin, and Humphries¹ calculated, from 214 reports of combines equipped with auxiliary engines, that the rate of cutting would be increased 0.27 acre by the addition of each foot to the length of the cutter bar.

¹ U. S. Dept. Agr. Tech. Bull. 70, p. 14, 1928.

They also stated that

... on this basis a 10-foot machine in 20-bushel wheat, traveling 2.5 miles per hour, should cut 20.5 acres in a 10-hour working day. A 12-foot machine should

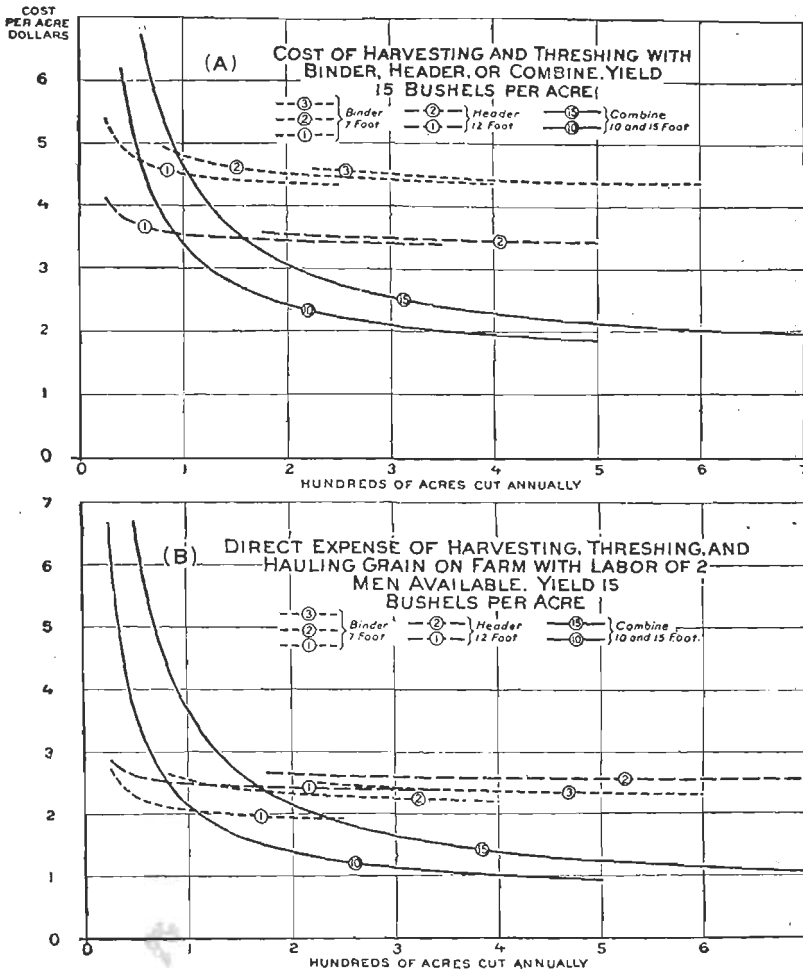


FIG. 540.—Comparative harvesting, threshing, and hauling cost with binders, headers, and combines. (U. S. Dept. Agr. Tech. Bull. 70, p. 31, 1928.)

cut 25.9 acres, a 15-foot machine 34 acres, a 16-foot machine 36.7, and a 20-foot machine 47.5 acres.

A 10-foot combine should harvest 375 acres in a 15-day harvest season. The minimum profitable acreage in the Great Plains for a machine of this size is about 150 acres; the maximum is about 640 acres. A 15-foot combine should harvest 525 acres in 15 days, with a minimum of 200 and a maximum of 1,100 acres.

Table XX shows the average rate of travel, the length of day, the acres cut per hour, and per foot of width by combines of different types and sizes.

581. Harvesting Losses.—The figures given by Reynoldson, Kifer, Martin, and Humphries show that the average harvesting loss with combines is 2.6 per cent of the total yield as compared with 3.3 per cent for a header and 6.1 per cent for a binder. The actual loss of grain cut with the combine averaged 32 pounds per acre, as compared with 40 pounds with the header and 74 pounds with the binder.

TABLE XX.—ACRES CUT PER HOUR AND PER FOOT OF WIDTH BY COMBINES OF DIFFERENT TYPES AND SIZES¹

Type of combine	Width of cut, feet	Combines, number	Yield per acre, bushels	Rate of travel, miles per hour	Length of day, hours	Cut per day, acres	Cut per hour, acres	Cut per hour per foot of width, acres
Tractor drawn with power take off.....	{ 8	25	17	2.4	10.3	16	1.6	0.19
	{ 10	10	24	2.7	9.8	26	2.6	0.26
Tractor drawn with auxiliary engine.....	{ 12	56	17	2.8	10.2	27	2.6	0.22
	{ 15	51	18	2.8	10.3	35	3.4	0.23
	{ 16	104	21	2.8	10.7	40	3.7	0.24
	{ 20	3	25	2.4	10.7	48	4.5	0.22
All tractor drawn.....	.....	249	19	2.8	10.4	33	3.2	
	{ 12	3	11	2.5	10.0	23	2.3	0.19
Horse drawn.....	{ 15	3	13	2.7	10.2	30	2.9	0.19
	{ 16	2	14	2.5	11.5	38	3.3	0.21
All horse drawn.....	.....	8	12	2.5	10.3	29	2.8	

¹ U. S. Dept. Agr. Tech. Bull. 70, p. 40, 1928.

CHAPTER XXVIII

CORN SHELLERS, HUSKERS, AND SHREDDERS

CORN SHELLERS

After the corn has been harvested it is necessary to prepare it for the market by separating the kernels from the cob. There are two types of corn shellers: "spring," and "cylinder."

582. Spring Shellers.—Spring shellers are of various sizes listed according to the number of holes provided for shelling. The sizes are one-hole, two-hole, four-hole, and six-hole. The one-hole and two-hole

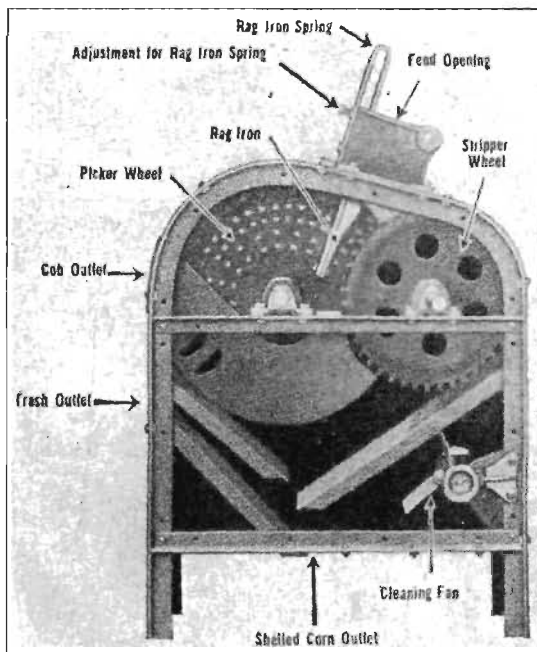


FIG. 541.—Sectional view of one-hole spring corn sheller.

sizes are small hand or power shellers, while the four-hole and six-hole sizes are larger power shellers. Figure 541 shows the various parts of a one-hole sheller, while Fig. 542 shows a two-hole sheller.

Referring to Fig. 542, the shelling operation is as follows: The corn is delivered to the feeder *A*. The ears fall on the feeder chain *B* and are carried into the picker wheels *C*. The beater *D* aids in feeding and pre-

vents the ears from bridging. The kernels are shelled from the cob as the ears pass between the runners *E* and *F* and the rag iron *G*. The tension on the rag iron can be adjusted by the thumb nut *H* so that small or large ears can be shelled.

The shelled corn drops through the shelling wheels onto incline *I*. The cobs, husks, and silks drop onto a wire cob rake *J* which is agitated by the eccentric sprocket *K*. The shelled corn that passes on with the cobs and that from incline *I* fall through the wire cob carrier *J* onto the cleaning sieve *L*. As the corn falls from the sieve *L* to the pan below, it

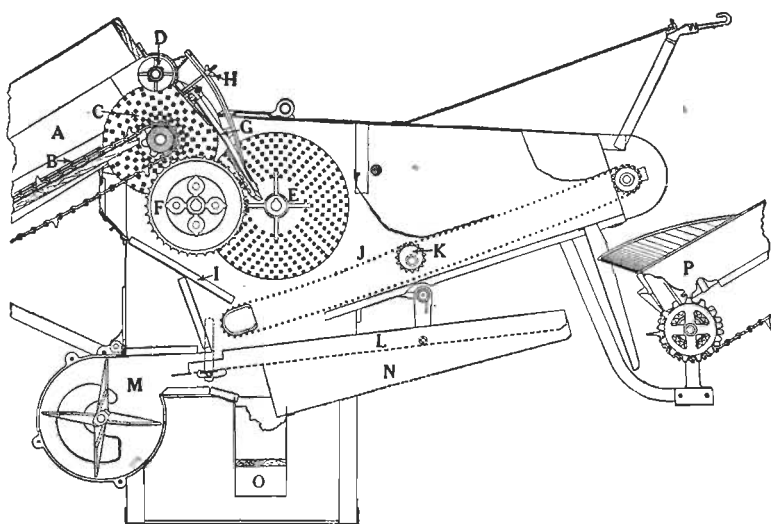


FIG. 542.—Sectional view of two-hole spring corn sheller.

is subjected to a blast of air which separates the chaff, silks, and small cob ends from the shelled corn. The grit and sand are removed as the shelled corn gravitates down over the sand screen *N*. The clean corn is delivered to the boot *O* and carried outside the machine. The cobs, silks, and other foreign material pass over the cob rake into the swinging cob stacker *P*.

583. Cylinder Shellers.—The cylinder shellers have a different shelling device from that of the spring shellers. In general, the device is composed of a series of adjustable staves, forming a cylinder, in which revolves the main shaft to which are keyed a series of shelling rings (Fig. 543). It is the action of these rings revolving the ear around the cylinder which shells the kernels off the cob.

The complete operation of shelling is as follows: Referring to Fig. 544, the ear corn is delivered into the feeder *A* which carries it up and drops it through chute *B* into the feeding auger *C*. The ears pass between the shelling staves or concaves *D* and the shelling rings *E*. The staves can

be adjusted by cranks *F*. The cobs pass through openings *G* and fall upon the vibrating cleaning shoe *I*. As the husks, silks, and foreign matter pass through openings *G*, this material is agitated by the revolving

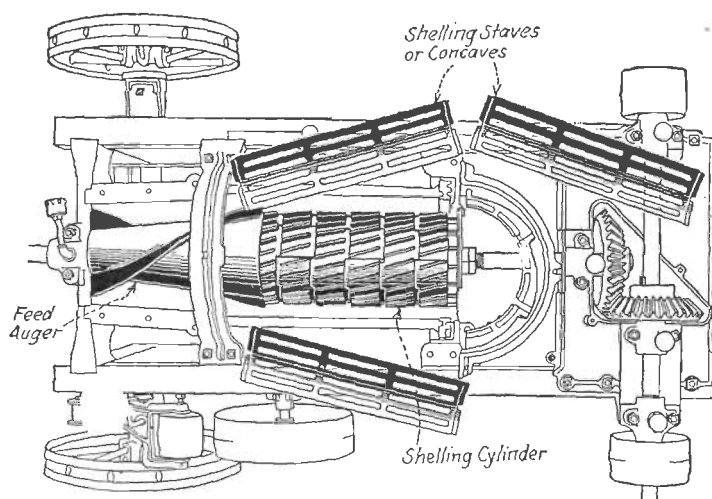


FIG. 543.—Shelling cylinder and staves. The staves are removed so that the shelling cylinder can be seen.

paddle *H* which assists in separating much of the shelled corn from the foreign matter before it reaches the vibrating shoe. Most of the shelled

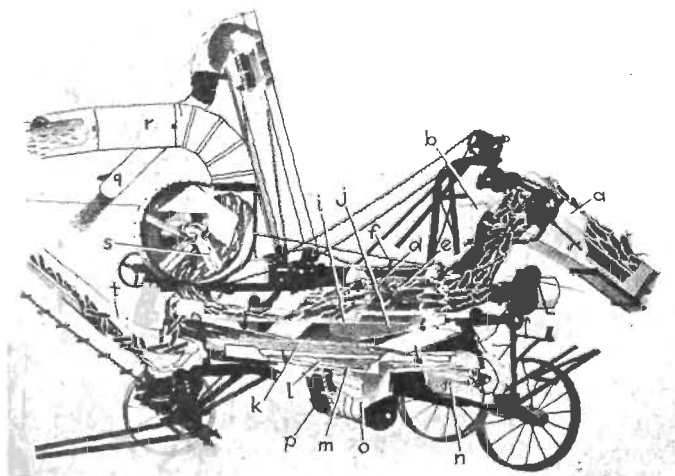


FIG. 544.—Sectional view of cylinder corn sheller, showing action of the various parts.

corn passes downward through the shelling cage onto pan *J*. The corn that passes onto the vibrating shoe *I*, with the cobs and husks, is separated by the vibrating motion of this shoe and falls through onto the lower

cleaning shoe *K*. From this shoe, it falls through onto pan *L* as it gravitates towards the elevator auger *O*. It passes over sand screen *M* which separates the sand and grit from the shelled corn. As the shelled corn passes down from the upper cleaning shoe *I* and from the shelling cage toward the auger *O*, it is subjected to a blast of air from fan *N* which takes out silks, chaff, and cob ends. The corn then falls into the auger *O* and is delivered to the elevator *P* which elevates and delivers it to the wagon box through spout *Q*. As the cobs pass toward the end of the shoe *I*, they are subjected to suction from fan *S* which separates the dust, dirt, and

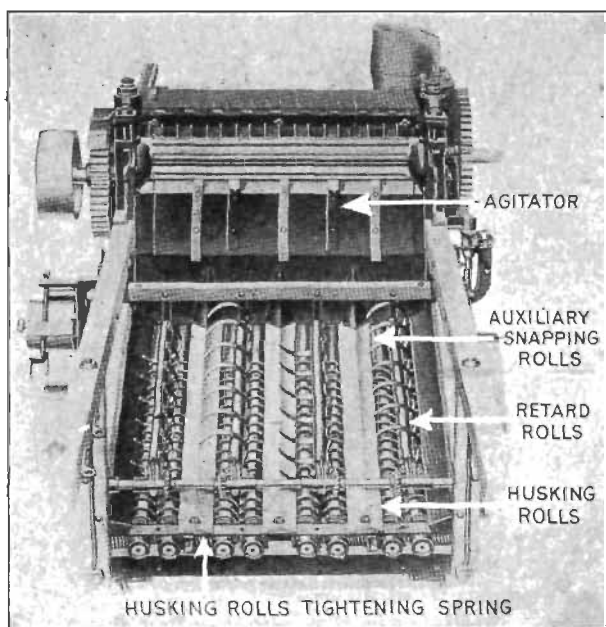


FIG. 545.—Overhead view of husking rolls.

husks from the cobs and delivers this foreign matter in a separate pile, through pipe *R*. The cobs free of all foreign matter are delivered into the cob stacker *T* which elevates and deposits the cobs away from the machine.

584. Capacity of Shellers.—The capacity of the one-hole spring sheller is limited by the power available and the requirements. The power two-hole spring sheller will shell from 60 to 125 bushels per hour; the four-hole from 150 to 250 bushels per hour; the six-hole 250 to 400 bushels per hour. One company makes an eight-hole sheller which has a capacity of 400 to 600 bushels per hour.

The smaller sized cylinder shellers have a capacity of 100 to 250 bushels per hour of snapped corn and from 250 to 400 bushels per hour of husked

corn. The larger sized cylinder shellers will shell 200 to 425 bushels of snapped corn and from 600 to 1,000 bushels husked corn.

HUSKER-SHREDDERS

The husker-shredder is a machine which removes the ears from the stalks; then, it removes the husks from the ears and also shreds the stalks,

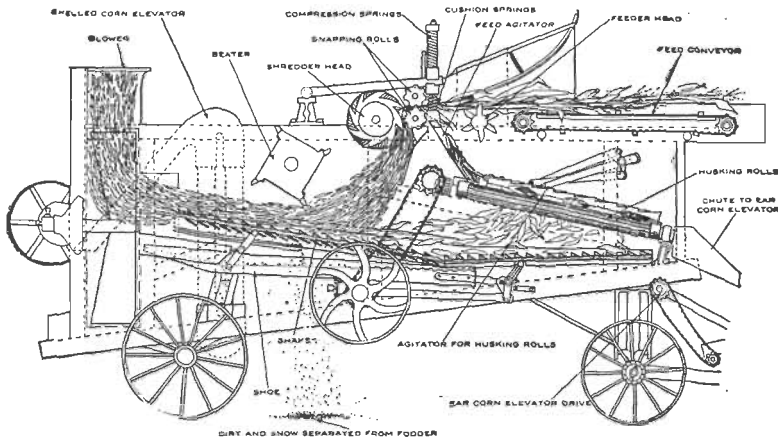


FIG. 546.—Sectional view of husker-shredder

blowing them with the husks into the barn (Fig. 546). The machine handles corn that has been cut and shocked. The husker-shredder husks quickly and makes practically all of the *stover* available for feed.

585. Size.—The size of a husker-shredder is designated by the number of husking rolls with which the machine is equipped and is known as a

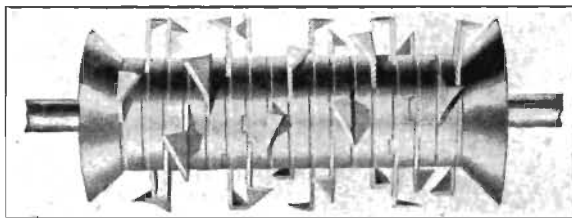


FIG. 547.—Knife-shredder cylinder.

two-, four-, six-, eight-, or ten-roll machine. Figure 545 shows the arrangement of the rolls for an eight-roll machine. The husking rolls operate in pairs.

586. Operation.—A cross-sectional view of a husker-shredder is shown in Fig. 546. The stalks with the ears on them are thrown on the feed conveyor, and the feeder head feeds them into the snapping rolls where the ears are removed from the stalks. The ears drop down upon the husking rolls where the husks are removed, after which the ears pass out

of the machine, while the husks are carried back over the shaker. Any kernels of corn that might have been shelled by the husking rolls are removed by the shaker.

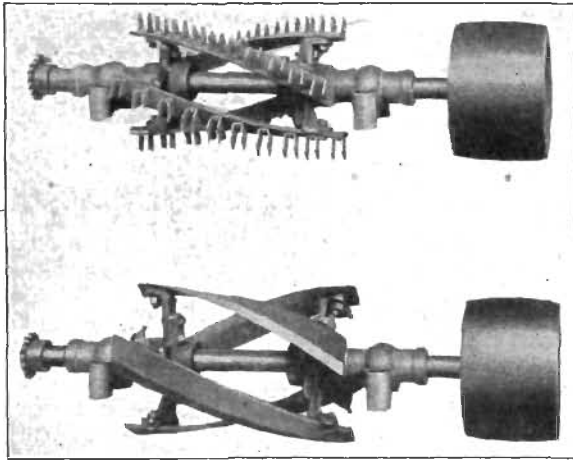


FIG. 548.—Shredding and cutting cylinders.

As the stalks pass through the snapping rolls, they come in contact with the shredding cylinder (Fig. 547) which thoroughly shreds the leaves and stalks. The shredder material or *stover* is carried to the blower where it is blown into the barn or other storage place. Sometimes a cutting cylinder (Fig. 548) is used instead of the shredding cylinder. The stalks are cut into short lengths like silage.

CHAPTER XXIX

THE COTTON GIN AND EQUIPMENT

The most important operation in the production and preparation of cotton for the market is the separation of the lint from the seed, a process known as *ginning*.

The history of the practical cultivation of cotton in America dates from 1621, when it was introduced into what is now the state of Virginia, with seed from the East Indies. At that time the lint was picked from the seed by hand, as shown in Fig. 549.



FIG. 549.—Negroes picking lint from cotton seed before the invention of the cotton gin.

The first known mechanical means of separating the seed from the lint is shown in Fig. 550. This primitive device would handle sea-island or long-staple cotton but was practically useless when applied to short-staple cotton.

Consequently, when Eli Whitney invented the saw gin, a model of which is shown in Fig. 551, it proved to be an epochal event. The patent was issued to Eli Whitney on Mar. 14, 1794, signed by George Washington, President; Edmund Randolph, Secretary of State; and William Bradford, Attorney General.

587. Gin Types.—There are two types of gins, the roller and saw. The former is not extensively used while the latter is practically a universal type.

THE ROLLER GIN

Figure 552 shows the working parts of a roller gin. The lint is pulled from the seed by a walrus hide covered roller *B* assisted by the fixed knife *D* and a moving knife *F*.

A roller gin has a very small capacity being about one bale in ten hours.

THE SAW GIN

Some of the large custom ginning plants of today often require an investment of \$60,000 or \$90,000. During a good crop year such a plant may gin as

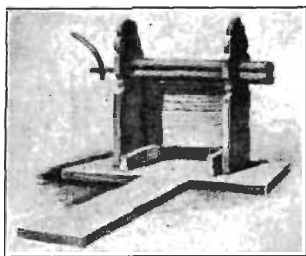


FIG. 550.—The Churka, the first-known cotton gin.

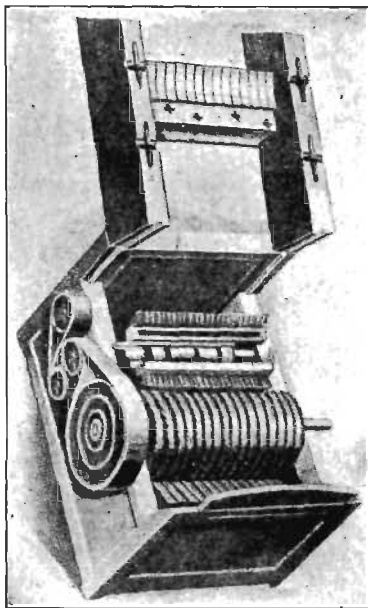


FIG. 551.—Model of Whitney's first saw gin.

many as 5,000 bales of 500 pounds each. The small plantation gin,

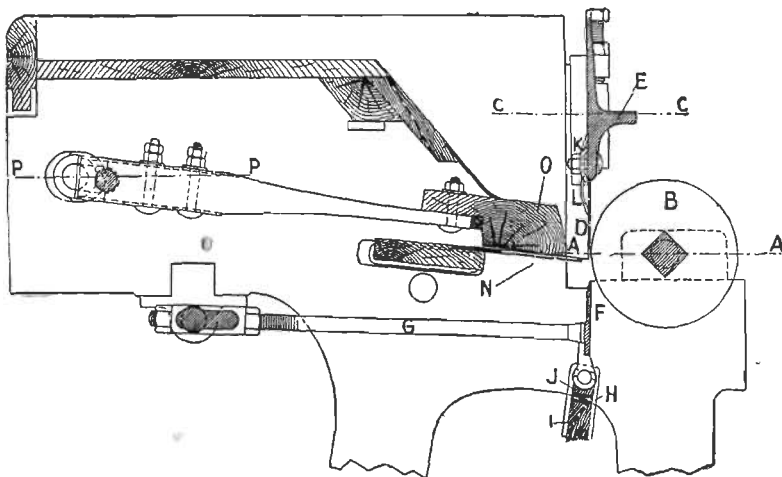


FIG. 552.—Cross-section of roller gin.

which may not gin more than 200 bales per season, does not require such a large investment.

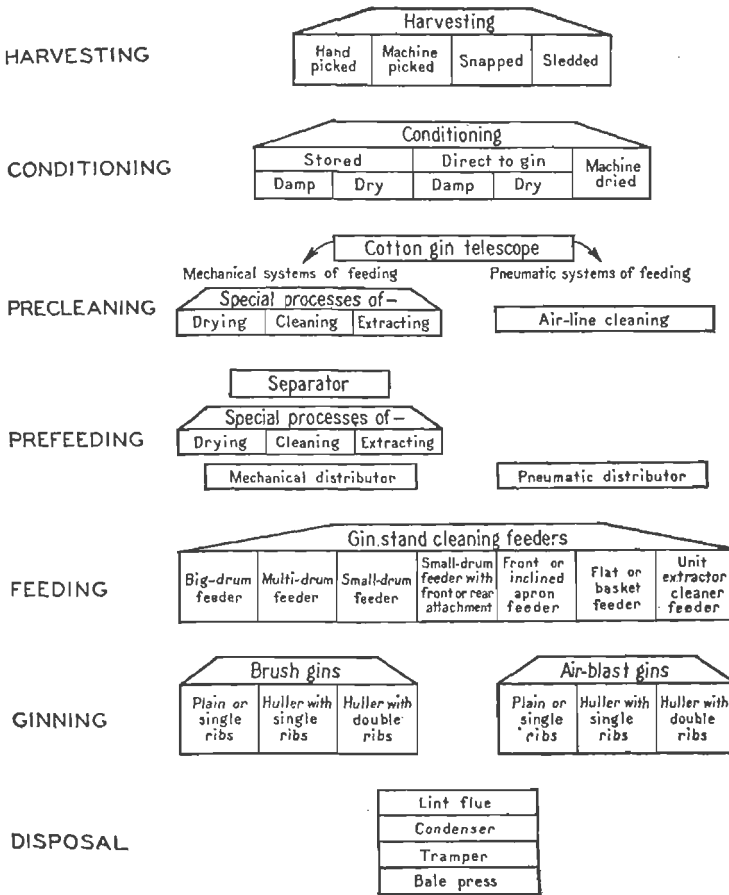


FIG. 553.—Diagram showing various steps and processes involved in ginning cotton. (U. S. Dept. Agr. Farmers' Bull. 1748.)

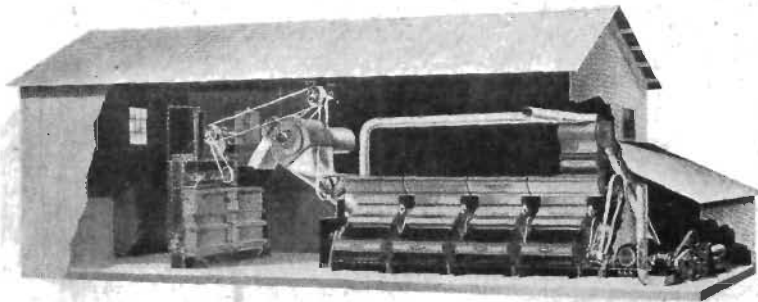


FIG. 554.—One-story electrically operated gin showing mechanical distributor and drowsy press.

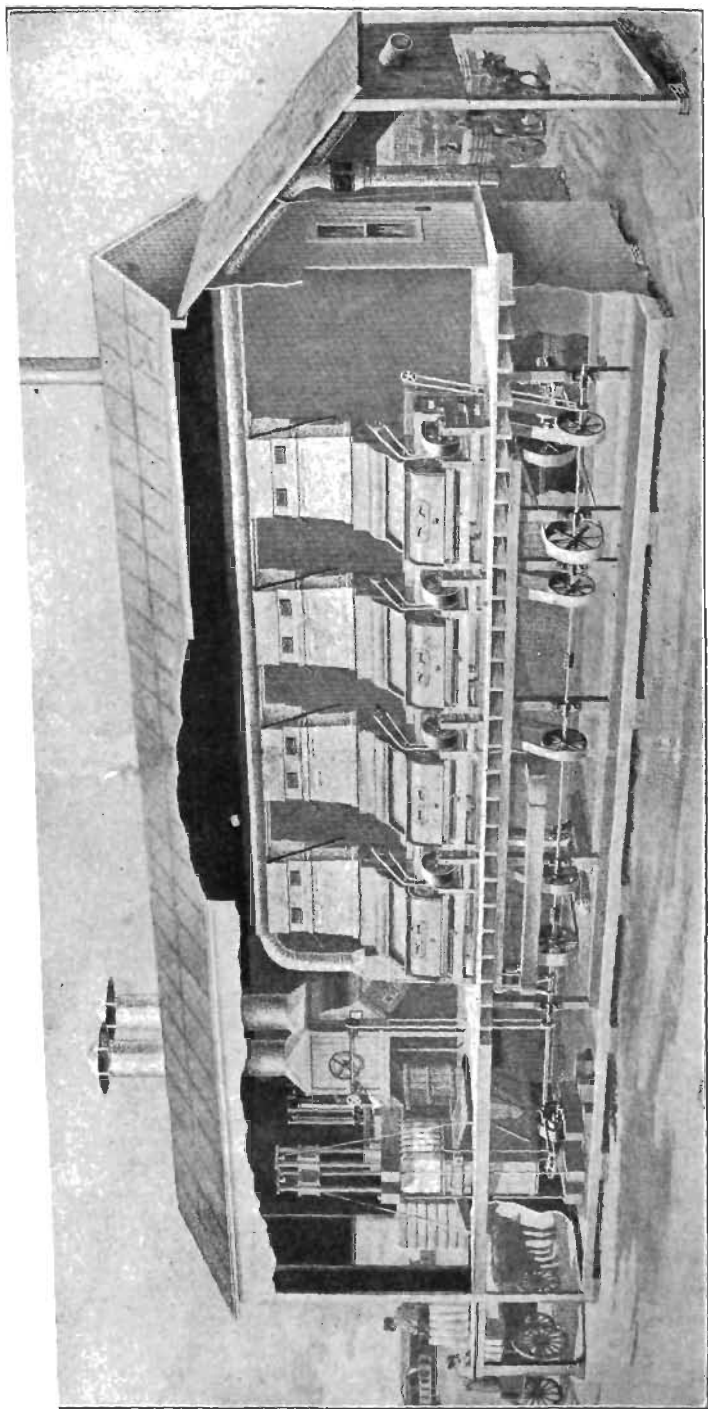


FIG. 555.—Two-story gin with pneumatic elevator distributor.

588. Gin Outfits.—In general, there are two methods of installing gin outfits. These are: a one-story construction, as shown in Fig. 554 and a two-story system, shown in Fig. 555. There are many arguments for and against each method of installation but it seems that the one-story outfit is the more commonly used. It is obvious that a gin installed on the ground will give less vibration, resulting in less wear and deterioration of the machinery. When placed on a concrete floor, the fire risk is less which in turn lowers the cost of insurance.

ELEVATOR

The elevator consists of a telescoping pipe through which the cotton is sucked from the wagon, trailer, or truck up to a separator where the cotton is removed from the air and dropped into the cleaning apparatus or into the distributing system.

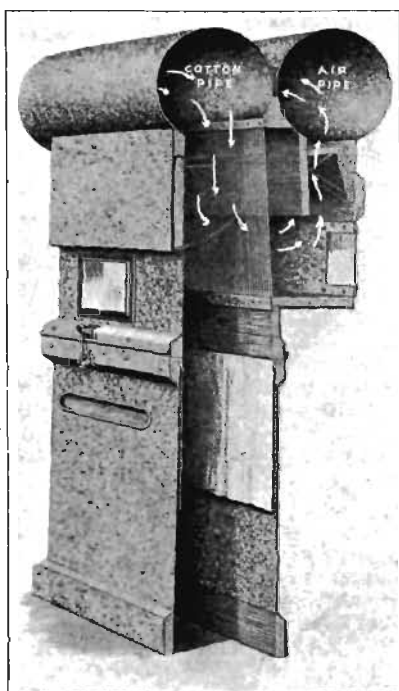


FIG. 556.—Sectional view of pneumatic elevator showing cotton and air pipes.

DISTRIBUTORS

There are three types of distributors for distributing cotton to the feeder chutes, namely, the pneumatic, belt, and screw conveyor.

589. The Pneumatic Distributor.

This type of distributor consists of two pipes extending over the gin stands. The double pipes, as shown in Fig. 556, are joined together but are separated by a heavy wire-screen partition. The pipe that draws the cotton from the wagon is called the *cotton pipe*, and the one that connects with the fan is called the *air pipe*.

590. Belt Distributor.—The operation of the belt-distributor system, is the same as in the case of the pneumatic system up to the point where the seed cotton is taken out of

the air. The same type of fans, suction pipe, and telescope is used in each system.

The apparatus for taking the seed cotton from the air in the belt distributor system is termed a *separator dropper*, or *vacuum dropper*. In general, the separator or dropper consists of a wire-mesh screen through which the air may pass, but the cotton may not (Fig. 557). The screen is so curved or shaped that cotton in its rapid travel in the air-suction current strikes the curved surface of the screen obliquely so that the

cotton by gravity falls to the belt of the distributor, which distributes it to the various gin stands.

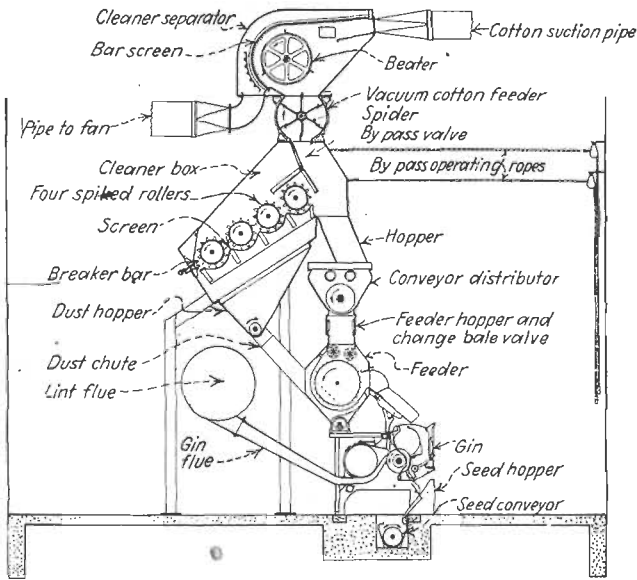


FIG. 557.—Sectional view of gin system.

The belt is 8, 10, or 12 inches in width and has metal spikes some 4 inches long fixed to it at regular intervals. The belt is inclosed in a double boxing so that when the seed cotton falls upon the upper or top part, it is carried around into the lower section and distributed to the feeders. When the feeders are full, the surplus cotton is carried to the end of the belt box and dropped on the floor. The surplus cotton is called the *overflow*.

When all the cotton has been removed from the wagon, the suction is switched and the cotton from the overflow again passes through the separator and belt distributor.

In the west and other sections of the cotton belt where various form of cleaners are interposed, the belt distributor is used extensively.

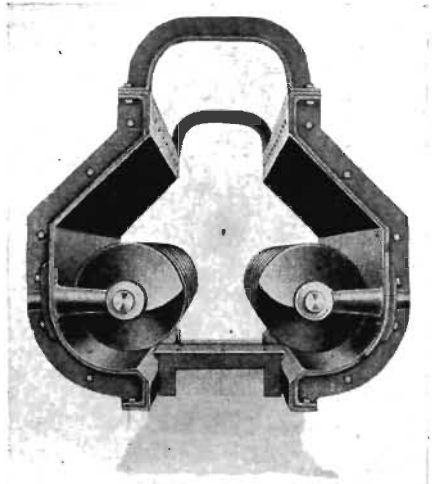


FIG. 558.—End view of double-screw conveyor distributor.

591. Screw-conveyor Distributor.—The screw-conveyor type of distributor system may consist of either a single-screw (Fig. 557) or a double-screw conveyor (Fig. 558). The screws or spiral augers push the cotton along the conveyor trough and drop the cotton into the feeder chutes of the various gin stands. If all feeder chutes become full, the surplus cotton is discharged at the end on the floor.

CLEANER FEEDERS

592. Feeder.—The feeder is interposed between the distributing chutes and the gin stand. It really connects the elevating and distributing system with the gin.

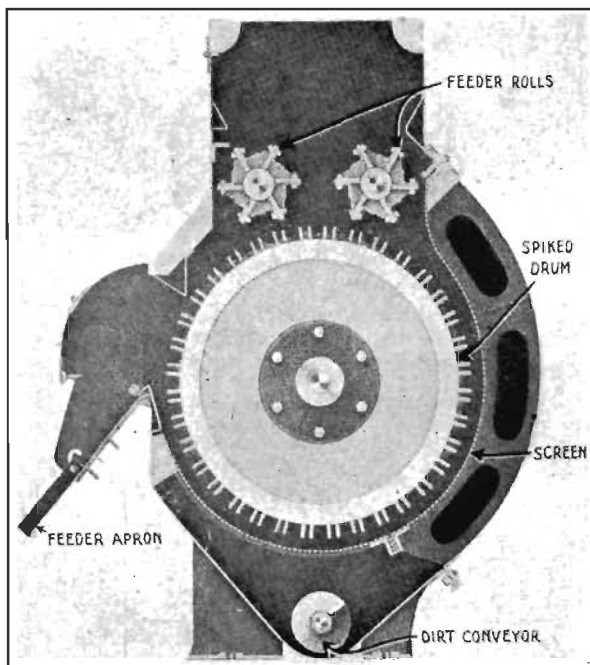


FIG. 559.—Sectional view of feeder cleaner.

At the top of the feeder and forming a bottom for the chute are located two fluted rollers (Figs. 557 and 559) which slowly feed the seed cotton into the cleaning division of the feeder.

593. Cleaner.—The cleaner parts consist of rapidly revolving drums or cylinders which are studded with spikes (Fig. 559). This drum is usually operating at a speed of approximately 300 revolutions per minute.

The projecting spikes strike the cotton as it is brought down by the fluted rollers and knock it against a heavy wire screen which partially encircles the drum. The cotton is forced along over the surface of the wire screen around the periphery of the drum and discharged by centrif-

ugal force at a point just above the front or breast of the gin. Usually a hood directs the cotton downward into the breast of the gin.

The beating action of the spiked drum removes a portion of the dirt, dust, and trash which drops through the screen and is carried out by a screw conveyor.

594. Rate of Feeding.—Much depends upon the rate at which the seed cotton is fed into the gin. The amount of cotton fed is regulated by the speed at which the fluted rollers revolve.

There are many types of feeder gearing to operate the feeder rollers. The conventional type consists of a ratchet and pawl operated by an eccentric on the cleaner drum shaft (Fig. 560). Worm gears (Fig. 561) and a paper friction drive are also used.

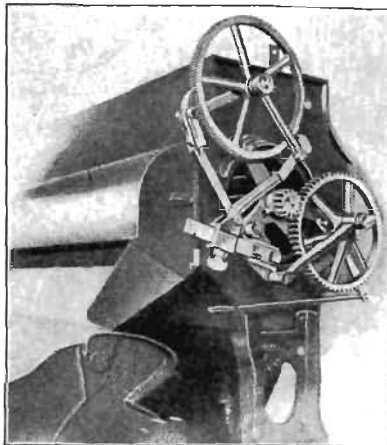


FIG. 560.—Automatic ratchet-feeder gearing.

THE GIN

The function of the gin is to separate the lint from the seed. The principal parts necessary to perform this function are the saws, ribs, and a brush or a blast of air for cleaning the lint from the saws.

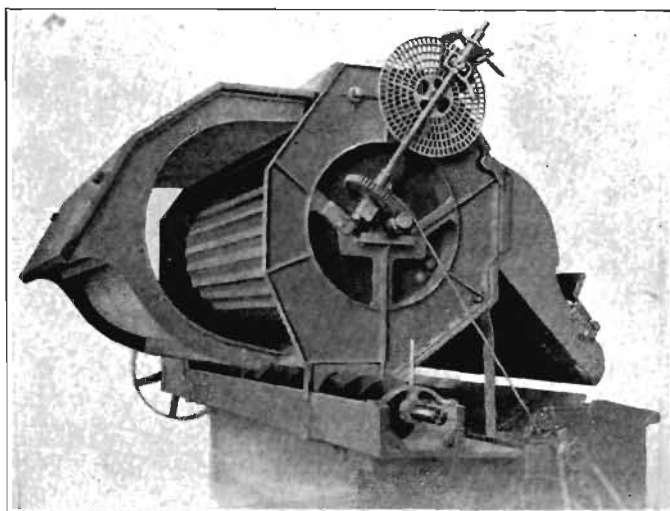


FIG. 561.—Feeder cleaner equipped with worm-gear feed control.

595. Types.—There are three types of gins, depending upon the type and number of ribs: the plain, the single-rib huller, and the double-rib huller. These are shown in Fig. 562. The plain or single-breast gin is

only suitable for ginning clean cotton that has no boll, hulls, or trash. The double-rib huller breast or front is used most, because it gives protection to the gin saws and eliminates foreign matter like burs, hulls, and leaf trash.

596. Size of Gins.—The size of a single-gin stand is determined by the number of saws on the shaft which is usually 70 or 80. The size of the ginnery is determined by the number of gin stands and the number of saws per stand and is given as a 4-70 or 5-80. This means that there are 4 or 5 gin stands with 70 or 80 saws per stand. Such an outfit is also referred to as a single battery. A double-battery gin is one with two sets of gin stands—one set on each side of the building.

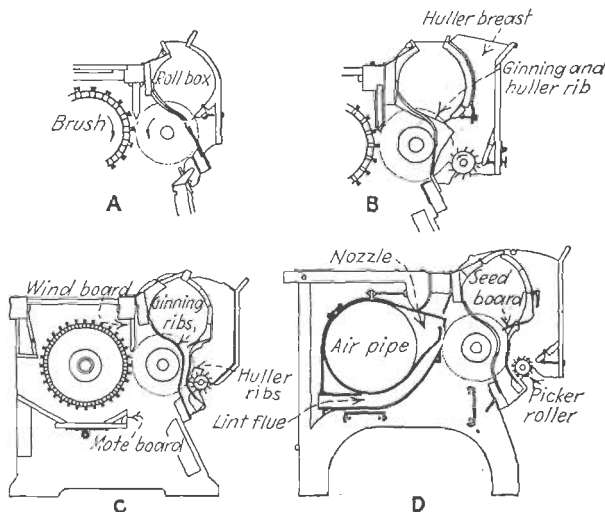


FIG. 562.—Kinds of gin breasts or fronts: A, plain brush gin; B, single-rib huller brush gin; C, double-rib huller brush gin; D, double-rib huller air-blast gin. (U. S. Dept. Agr. Farmers' Bull. 1748.)

597. Saws.—There are usually 70 or 80 saws in a gin stand, spaced by space blocks about $\frac{5}{8}$ inch apart. The saws are 10 or 12 inches in diameter. The 12-inch size is becoming the standard size. The speed of the saws depends on the type of ginning machinery. In the brush system the saws operate at a speed of 350 to 450 revolutions per minute. With the air-blast system, the saws run at a much higher speed. Usually 500 to 700 revolutions per minute. Killough and McNess¹ found that the speed at which the gin saws were operated did not seem to have any marked effect on the grade, length, and strength of the lint, provided a loose roll and the cleaning apparatus were used. Cotton which was ginned at a high saw speed using a tight roll was badly napped and

¹ Tex. Agr. Expt. Sta. Bull. 416, p. 21, 1930.

lowered the grade accordingly. Bennett¹ secured similar results in cotton ginning investigations at Stoneville, Miss.

598. Gin Breast or Front.—On the front of the frame and partially inclosing the saws is attached the breast or front. Figures 562 and 564 show that it is composed of the frame containing the first set of ribs, termed the *huller ribs*, the picker rollers, and the circular or elliptical compartment, called the *roll box*. ■

The gin breast with single- or double-picking rollers is used almost exclusively where cotton has many burs, bolls, and trash mixed with the seed cotton, and such cotton as has been gathered, sledded, pulled, or snapped.

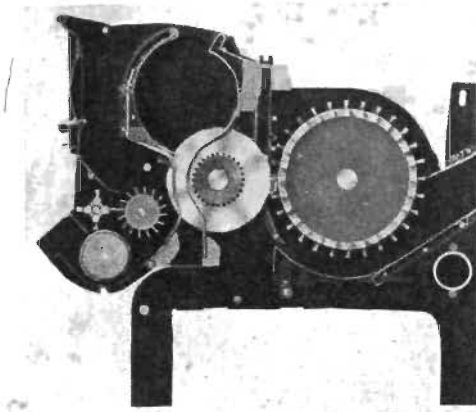


FIG. 563. —Cross-section of huller brush gin.

The cotton falls from the feeder into the huller roll box where it comes in contact with the picker roller, which is fitted with a number of projecting spikes. As it revolves the seed cotton is presented to the segment of saws projecting through the huller ribs (Figs. 563 and 564). The saws pull the seed cotton through the huller ribs into the roll box, while the picker roller drops the hulls below.

599. Ribs.—In the plain gins there is only one set of ribs, while on the huller gins there are two sets. If one refers to Figs. 562 and 564, it is seen that the *huller ribs* form a portion of the front of the roll box while the *ginning ribs*, the ribs which separate the seed from the lint, form a portion of the rear part of the roll box.

The saws project through the *ginning ribs* into the roll box and engage the cotton fiber. The ribs are spaced close enough together that the saw may pass between but the cotton seed may not.

The ribs are so shaped that the partially stripped seed are pressed forward and upward by the pressure of other seed brought forward by

¹ U. S. Dept. Agr. Tech. Bull., 503, p. 15, 1936.

the saw teeth as the lint is engaged. The continuing of this process causes the whole mass in the roll box to revolve.

When the lint has been removed from a seed, it falls by gravity between the saws through an opening to a seed conveyor.

600. Roll Box.—The roll box is the round or elliptical compartment just above the saws, as shown in Figs. 562 and 564. It is in this compartment that the actual ginning takes place. To repeat, the seed cotton is pulled between the huller ribs by the saws, into the roll box. Then, as the teeth on the saws engage the fiber pulling the seed to the front, the mass revolves. There is a great deal of argument among ginnermen as to whether or not this mass of partially ginned cotton should be *tight* or *loose*. Killough and McNess¹ and Bennett² secured better results in every case when the roll was set to run loose. The samples of lint were smoother, showed no gin cutting or napping, and graded higher than lint taken from cotton which was ginned with a medium or tight roll. A tight roll often caused the seed to be damaged, and in some cases the seed were badly hulled.

Usually the rate of feeding determines the degree of tightness of the roll. Fast feeding will often cause a gin to choke, or the roll to become so hard and tight within the roll box that it ceases to revolve. The gin does not perform under such conditions. If the roll is too tight but continues to revolve, the result is, generally, a napped appearance in the cotton.

601. Brush System of Removing Lint from Gin Saws.—It is very essential that the lint be removed from the saws as quickly and thoroughly as possible after the saw teeth have passed between the ginning ribs. The original method was to use a rapidly revolving brush placed to the rear of the ginning ribs (Fig. 563). As a general rule, the brush operates at a surface speed of about three times that of the saw.

It is a debatable question whether the lint is removed from the saws by actual contact of the bristles or by the current of air created by the rapidly revolving brush. In either case, the lint is removed from the saw teeth and blown by the blast of air created by the brush into the *lint flue* located at the rear of the gin stand.

602. Air-blast System of Removing Lint from Gin Saws.—In the air-blast method of removing the lint from the gin saws, a fan is used to force a high-speed jet of air across a section of the saw teeth in such a manner that the lint will be blown through the lint passage directly into the lint flue (Figs. 562 and 564). The air-blast system is a comparatively new departure in gin manufacturing, but it is rapidly gaining favor.

¹ *Tex. Agr. Expt. Sta. Bull.*, 416, p. 21, 1930.

² *U. S. Dept. Agr. Tech. Bull.*, 503, p. 15, 1936.

The high velocity of air removes the lint from the gin saws so quickly that the speed of the saws can be greatly increased when this system is used. It is claimed that gin saws have been run at 1,000 revolutions per minute without injury to the lint. However, such high speeds are not advocated until they can be proved satisfactory by reliable research methods.

603. Motes.—When either the brush or air blast is used to remove the lint from the gin saws, the heavier particles, such as immature seed and small particles of trash called *motes*, will by weight gravitate to the lower edge of the air current and be separated from the lint. Special mote boards and conveyors are provided.

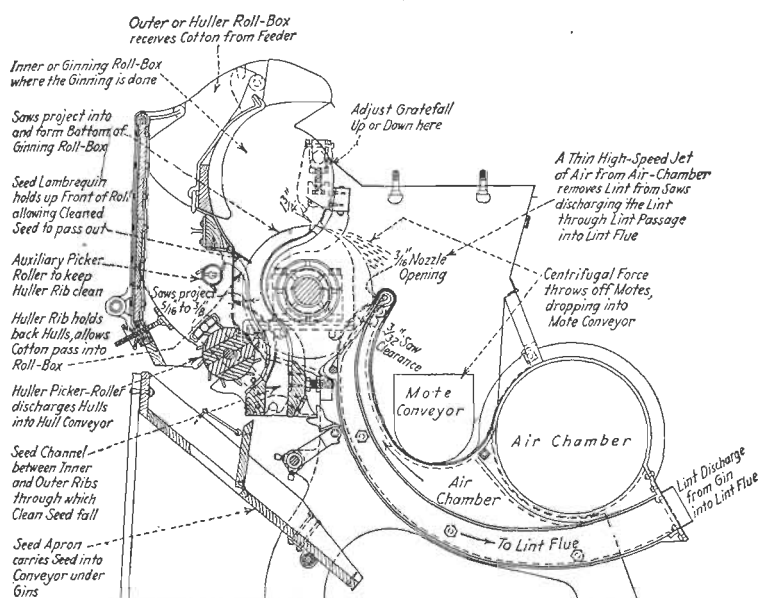


FIG. 564.—Cross-section of air-blast gin

One air-blast gin has a special-shaped air nozzle placed down far enough on the saw so that the motes are thrown from the saw by centrifugal force over the nozzle and are not affected by the current of air which passes from the air nozzle into the lint flue (Fig. 564).

604. Lint Flues.—When the lint is removed from the saws, it is in a loose fluffy condition and practically floats in the air currents produced by the rapid revolutions of the brush or by the current of air produced by the fan and emitted through the nozzle of the air blast.

As the lint is blown from the saws, it is conducted by an inclosed conduit fitted to the rear of the gin, called the *gin hood*, to the lint flue (Fig. 565) which also is a conduit for inclosing the air current with the contained cotton lint and conducting it to the condenser.

605. Condenser.—The condenser consists of a framework containing either one or two large circular screen drums, with a conduit for an air outlet. The single-drum type, as shown in Fig. 566, is more often used

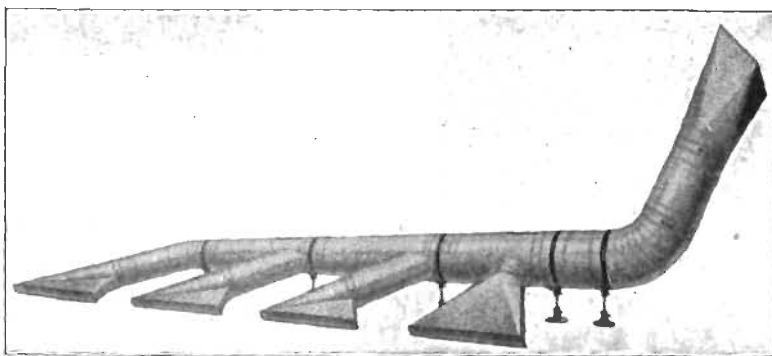


FIG. 565.—Lint flue system.

As the lint is blown from the lint flue, it is massed against the screen of the drum while the air passes through the wire mesh, thence out the ends of the screen drum and through *dust flues*, extending through the roof of the house, into the open air. The cotton is retarded by the screen inclosing the circular drum and slowly revolved to a position next to the press box, where it passes between the *doffing rolls* (Fig. 566) and is formed

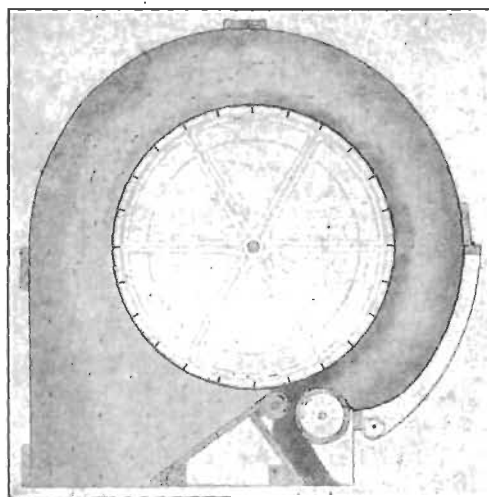


FIG. 566.—Single-drum condenser. Arrows show direction of air current. Shaded area shows travel of cotton.

into a *bat*. The bat of cotton slides down the inclined chute, or *lint slide*, into the press box. Automatic kickers are available that kick the cotton from the chute into the press box.

BALING APPARATUS

The operation of pressing the cotton into a press box and forming a bale is the last step in the preparation for the market. The baling apparatus consists of a press box, a means of pressing the lint into a condensed package, and a tramper.

606. Press Box.—The press outfit usually consists of two boxes arranged side by side and supported by a center column interposed between them, so they can be revolved under the condenser (Figs. 554

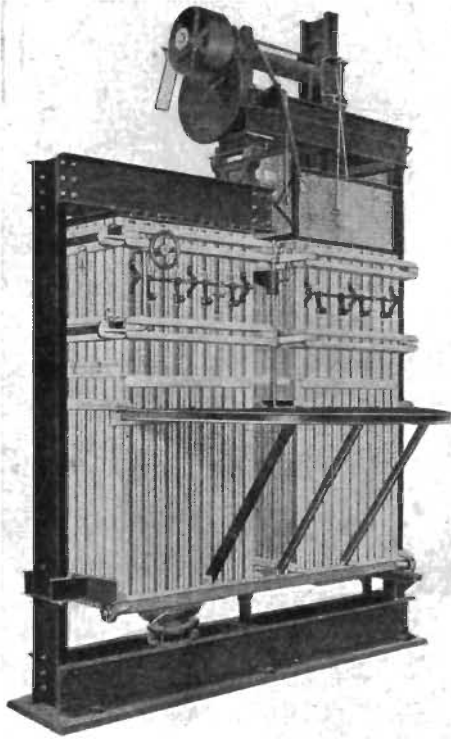


FIG. 567.—Up-packing, all-metal press box, showing mechanical tramper at top.

and 567). The box under the *lint slide* receives the cotton and is termed the *tramper side*, while the other, which is over the power, is termed the *press side*. Modern press boxes are constructed of heavy structural steel.

607. Size and Type of Bale.—The standard size box makes a bale 54 inches long, 27 inches wide, and approximately 45 inches deep. An average 500-pound bale of this size will have a density of 12 to 15 pounds per cubic foot. It will take 30 to 35 bales to fill a 36-foot box car. A standard compressed bale has a density of $22\frac{1}{2}$ pounds per cubic foot and 65 to 75 bales can be loaded into a car.

The bale is usually covered with 3 yards on top and 3 yards on the bottom of 2-pound jute bagging, making 12 pounds per bale, and is tied with steel ties, each weighing $1\frac{1}{2}$ pounds, making a total of 21 pounds per bale.

Some gins put out cylindrical shaped bales, known as *round bales*. They are approximately 35 or 36 inches long and 20 to 22 inches in diameter, and weigh from 250 to 270 pounds each. The bales are completely covered with a burlap bagging weighing $2\frac{1}{2}$ to 3 pounds. The cover is sewed on and holds the bale without ties. The density of a round bale

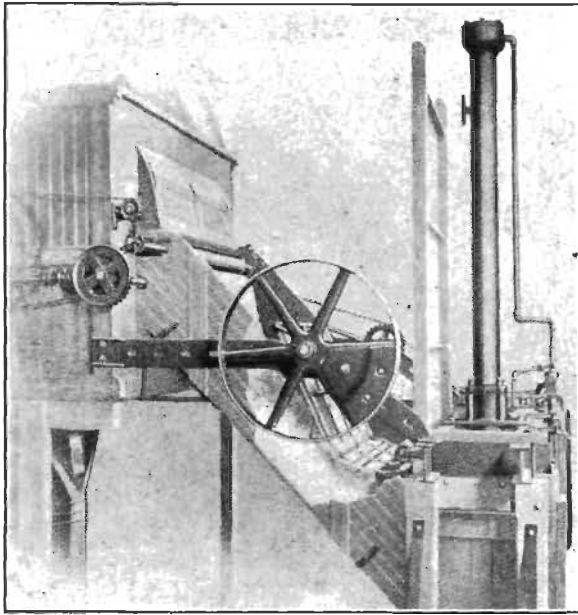


FIG. 568.—Automatic hydraulic tramper mounted on top of press box receiving lint cotton from the condenser.

is about 29 to 32 pounds per cubic foot. When cotton is put up in round bales, it usually carries a premium of 1 cent per pound.

608. Trampers.—Located well above the press box on the tramper side is the tramper. There are many types, which may be classified as friction, hydraulic, steam, and mechanical.

Figure 567 shows a mechanical tramper while Fig. 568 shows an automatic hydraulic tramper.

The function of the tramper is to loosely press the cotton into the press box as it comes from the condenser. Some trampers work automatically, while others operate only at the will of the attendant. Figure 568 shows the tramper in position to receive the lint as it slides down the lint chute from the condenser.

609. Presses.—When the cotton has been loosely tramped into the press box, on the tramper side, the boxes are revolved to bring the filled box over the press power.

The pressure required to reduce the cotton to the size and density of a standard bale is from 40 to 60 tons. To obtain this great pressure without overloading the power requires special power applications.

There are three methods in use: the screw press, the steam press, and the hydraulic press.

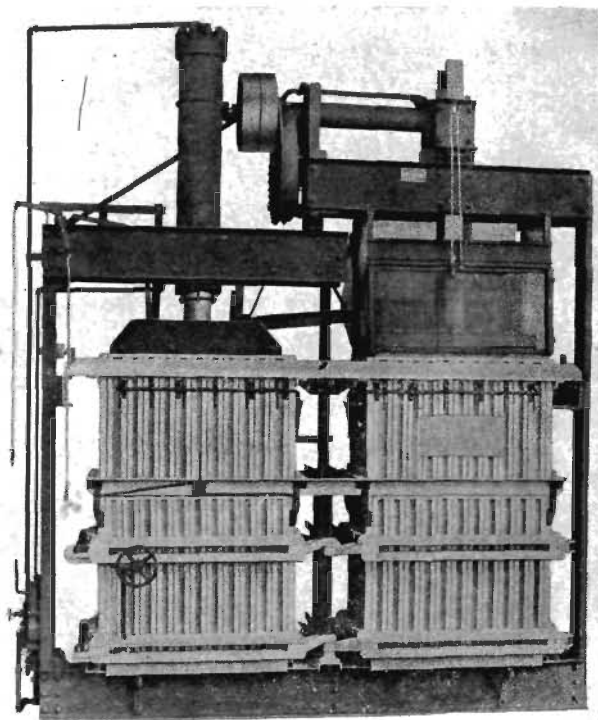


FIG. 569.—Down-packing, one-story, all-steel hydraulic cotton press.

Most of the presses are placed beneath the press box and press the cotton upward from the bottom (Fig. 567); however, Fig. 569 shows a hydraulic ram, mounted on top of the press box, which presses downward.

CLEANERS AND EXTRACTORS

The practice of gathering, pulling, snapping, sledding, and stripping cotton has made it necessary that the gin be equipped with special apparatus for cleaning and extracting the dirt, leaves, burs, and even parts of the stalk from the seed cotton. In sections where cotton is picked by hand, trash cleaners remove the loose foreign material, such

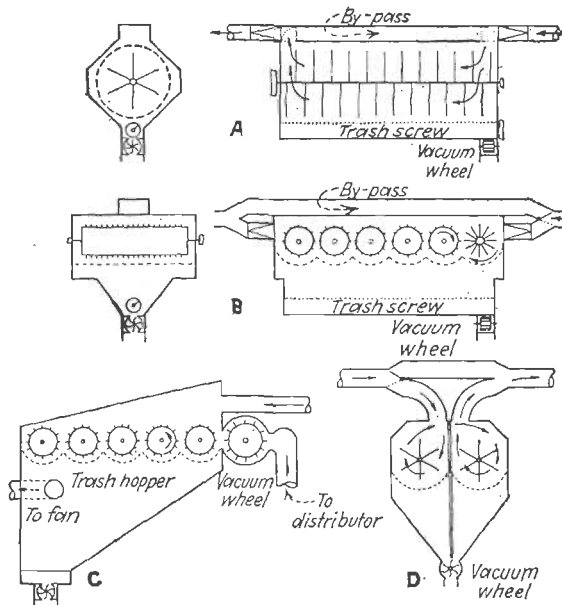


FIG. 570.—Air-line cleaners. (U. S. Dept. Agr. Farmers' Bull. 1748.)

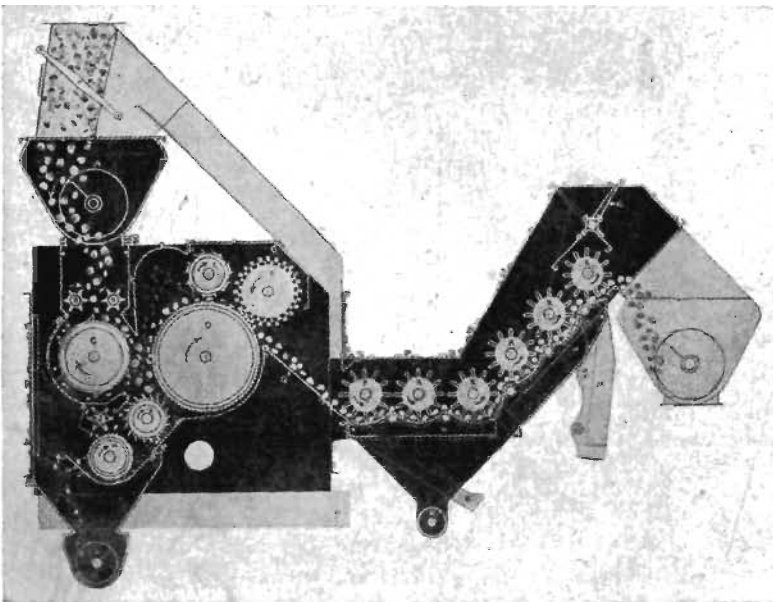


FIG. 571.—Cross-section of master-type hull extractor and cleaner.

as dust, sand, and fine leaf trash. This type of cleaning may be done with air-line cleaners or out-of-the-air cleaners. Where cotton is snapped, pulled, or mechanically stripped and contains burs, leaves, stems, and much coarse foreign matter, extractors and extractor cleaners must be used to process the cotton. Cleaners that clean the entire volume of seed cotton passing through the system are called *master cleaners*, and those that clean only the cotton for one gin stand are called *unit cleaners*.¹

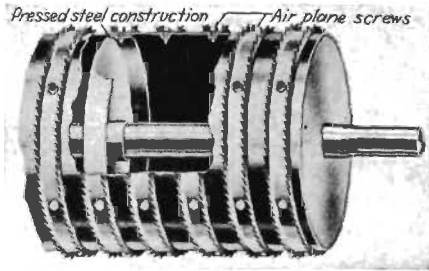


Fig. 572.—Section of extractor-cleaner saw drum.

610. Air-line Cleaners.—Hand-picked or extracted cotton can be cleaned with either air-line or out-of-the-air cleaners. Air-line cleaners

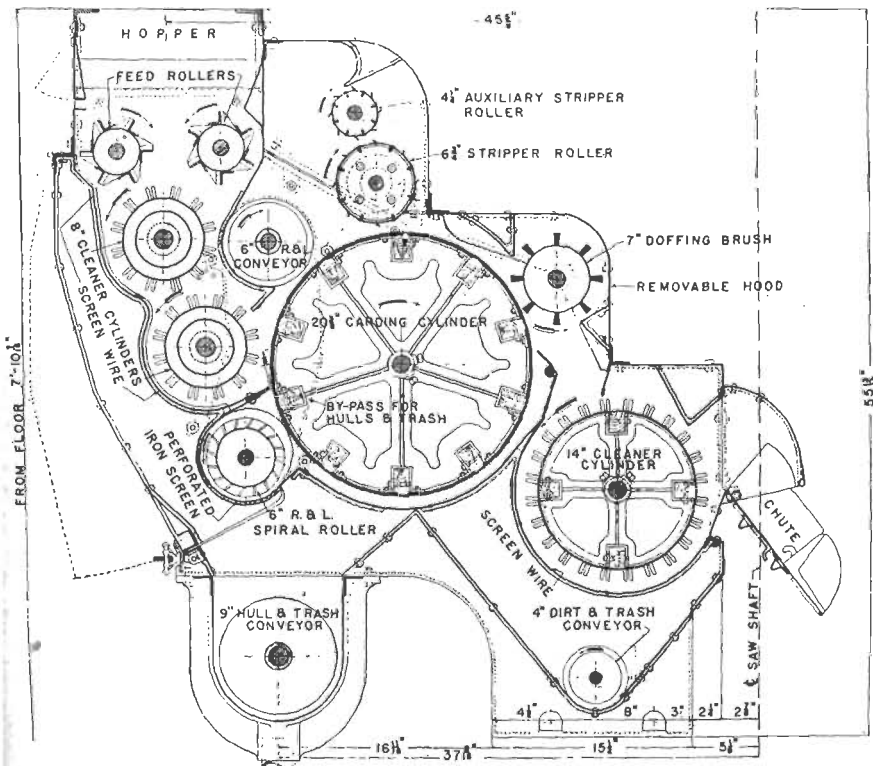


Fig. 573.—Cross-section of unit-type extractor-cleaner-feeder. Note the carding cloth on the drum.

are master cleaners so placed in the air line that the suction of air draws

¹ U. S. Dept. Agr. *Farmers' Bull.* 1748, p. 12, 1935.

the cotton through them. In passing through the cleaner, however, the velocity of the cotton is slowed down, permitting the beaters to act on the cotton and shake out foreign matter, which falls through a screen and is then discharged or trapped. Figure 570 shows several forms of air-line cleaners. Air-line cleaners are being replaced by unit cleaners on the gin stands.

611. Out-of-air Cleaners.—Cleaners that act on the cotton after it has been elevated from the wagon and removed from the air but before it reaches the gin stand are termed out-of-air cleaners. They may be used independently or in connection with extractors. An example of the latter

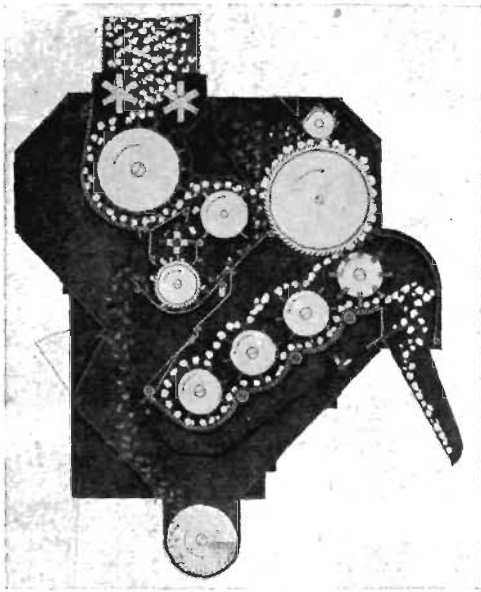


FIG. 574.—Cross-section of unit-type extractor-cleaner-feeder.

installation is shown in Fig. 571. These cleaners use some form of beater, either a spiked-drum, paddle-wheel, or spider-arm type. The spiked-drum type is shown in Fig. 571. The number of cleaning or beating cylinders may vary from 3 to 40, or more.

612. Extractor-cleaners.—“Extracting differs widely from cleaning because it holds locks of seed cotton on the teeth of circular saws (Fig. 572), cylinders, or belts (Fig. 573) while subjecting the locks to carding and beating action for removing foreign matter.”¹ There are numerous designs of both the master and unit types of extractors. The recent trend seems to be toward the unit extractor-cleaner-feeder. These are units that extract, clean, and feed the seed cotton directly into the gin front (Figs. 574 and 575).

¹ U. S. Dept. Agr. *Farmers' Bull.* 1748, p. 12, 1935.

613. Cottonseed Conveyors.—As the cottonseed drop from the gin saws, they fall into a trough in which operates a spiral-auger conveyor. All the seed from a battery of gin stands are conveyed out and discharged into a pit, where they are elevated by a bucket elevator and discharged into an elevated spiral-auger conveyor. This conveyor carries the cottonseed to the wagon bin if the customer is keeping his seed, or to the seed house if he is selling them to the gin. Figure 576 shows a typical conveyor system as used in the West. In the eastern part of the Cotton Belt it is a common plan to handle the seed by blowing them through pipes.

614. Seed Scales.—Figure 577 shows a modern arrangement of automatic scales for weighing cottonseed as they are ginned. Where the ginner buys the cottonseed, he can with a set of scales keep an accurate record of the

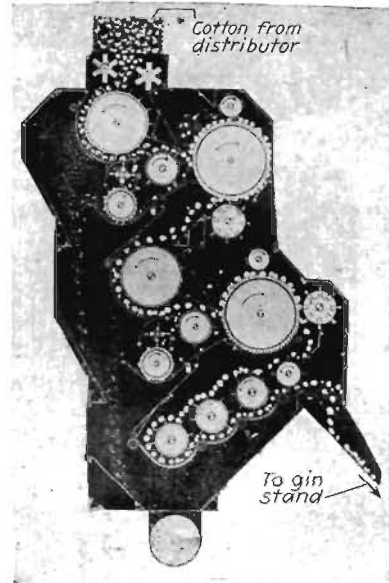


FIG. 575.—Cross-section of a two-unit type extractor-cleaners, one above the other. This type of machine is needed for very trashy cotton.

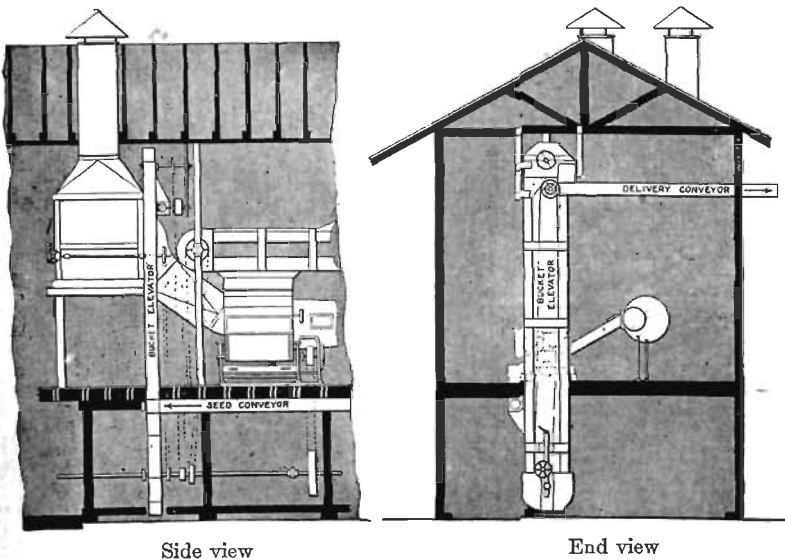


FIG. 576.—Cottonseed conveyor system.

seed he purchases. Many ginner still estimate the quantity of seed on a percentage basis.

615. Charge for Ginning.—The charge for ginning is usually based on the hundredweight of seed cotton. In Texas the charge ranges from 30 to 40 cents for picked cotton and 40 to 50 cents for snapped, pulled, and sledded cotton. The charge for bagging and ties is in addition to the charge per hundredweight of seed cotton. This charge ranges from \$1.50 to \$2 per bale.

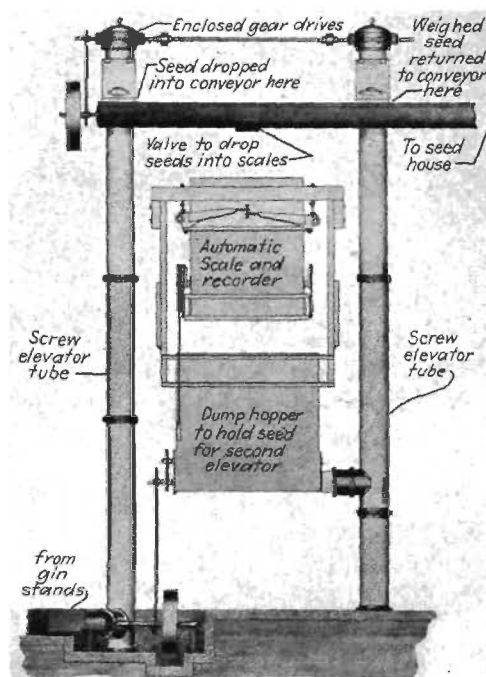


FIG. 577.—Automatic cottonseed weighing and recording scales with screw elevators and conveyor.

SEED COTTON DRIERS

Cotton harvested early in the season or early in the morning before the dew has dried may be too damp to gin without damaging the fiber. Under such conditions artificial drying will greatly improve the quality of ginning. Bennett¹ states that drying cotton artificially involves the following features: (1) The damp seed cotton is treated with a continuous current of hot air, at the rate of from 40 to 100 cubic feet of hot air for each pound; (2) the cotton is exposed to the drying process for different periods, usually from 15 seconds to 3 minutes, depending on the design of the drying apparatus; (3) the temperature of the drying air should preferably be between 150 and 160°F. for cotton handled during the early part of the ginning season although temperatures as high as 200° have been used satisfactorily with late season cotton.

¹ U. S. Dept. Agr., Misc. Pub. 239, p. 2, 1936.

PART X

FEED PREPARATION MACHINERY

CHAPTER XXX

FEED GRINDERS

In the feeding of livestock, it has been found that more animal nutrition and food constituents can be assimilated and put into flesh on an animal if the feed is ground, rather than left whole. Every farmer who has any livestock to feed, therefore, would find it advantageous to secure a small feed grinder to grind the feed before it is fed to the stock. Small feed grinders that can be operated by gasoline engines or small electric motors are preferable. These grinders can be divided into three types, depending upon the method of grinding; namely, the burr, hammer, and combination burr and hammer.

BURR GRINDERS

Most of the burr feed grinders (Fig. 578) are equipped with flat, roughened, chilled-iron plates which are often called *burr*s; hence, the

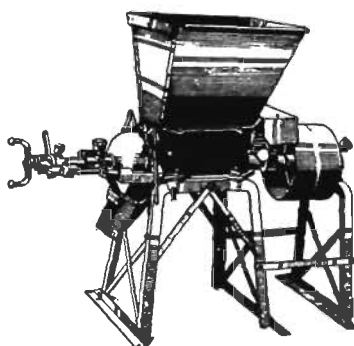


FIG. 578.—Typical burr-type feed grinder.

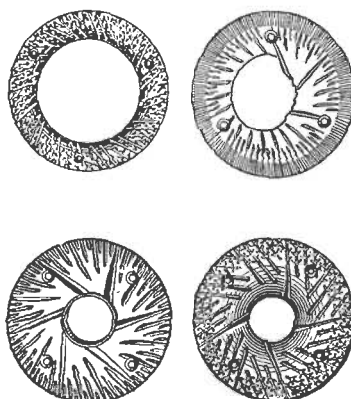


FIG. 579.—Typical plates used in burr mills.

name *burr grinders*. Burr feed-grinder mills are not generally adaptable to grinding roughages of high fiber content.

616. Types of Plates.—Figure 579 shows several plates having different grinding surfaces. Some of these are for coarse grinding, while others are for medium and fine grinding.

Some mills use plates having one grinding surface, as shown in Fig. 579, while others use a double face or duplex plate, as shown in Fig. 580.

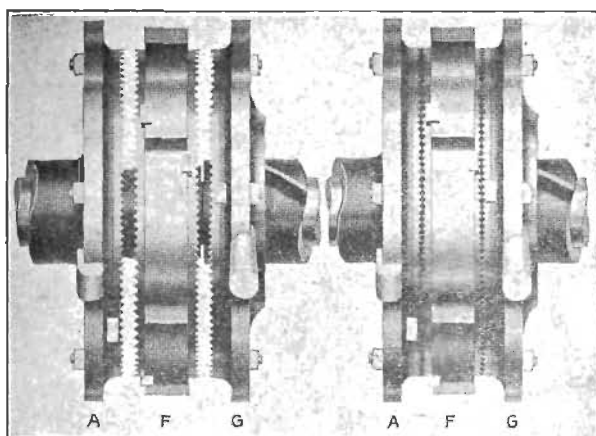


FIG. 580.—Duplex grinding plates.

Burr grinders are usually rated in sizes according to the diameter of the grinding plates, which are 6, 8, 10, and 12 inches. In operation one burr which revolves, is fastened to the drive shaft; the other burr is held rigid in and does not revolve.

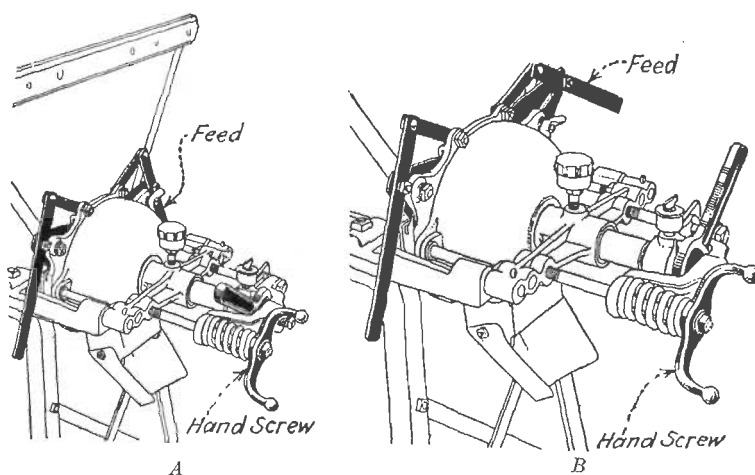


FIG. 581.—Adjust for fineness by hand screw and by closing feed gate: A, normal adjustment of mill when not in use; B, adjustment of mill when starting to grind.

617. Fineness of Grinding.—There are several factors that will influence the fineness of grinding in the burr grinders. They are the rate of feeding, type of plate, speed of plates, type of material being ground,

condition of plates, and tension between plates. Figure 581 shows a method of regulating the rate of feeding and also an arrangement for adjusting the tension between the plates.

The feed is fed into the center of the plate and is ground fine as it passes between the plates from the center to the outside edge, as shown in Fig. 582.

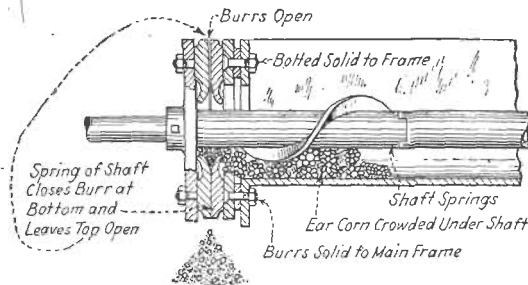


FIG. 582.—Illustrating how broken material is fed to the burrs.

618. Breaking and Cutting Rolls.—Before the feed, which is being ground, reaches the grinding plates, it is broken or cut into small pieces. Figure 583 shows a grinding mechanism suitable for breaking up and grinding ear corn from which the husk has been removed. The breaker roll breaks the ears and crushes the cobs against the concaves, and feeds the mixture into the grinding plates.

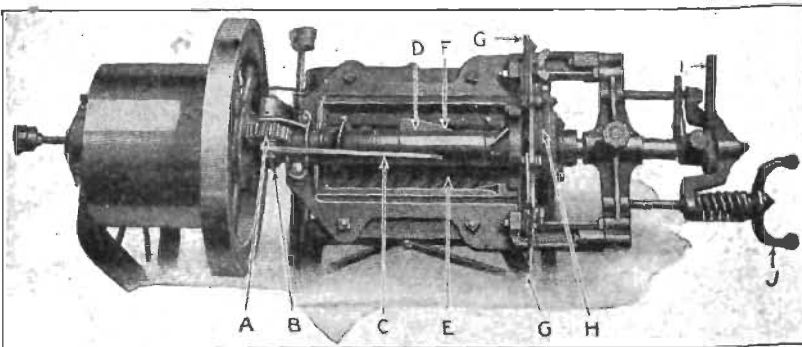


FIG. 583.—Grinding mechanism of type-B feed grinder: A, agitator driving worm; B, agitator driving gear; C, agitator; D, cob breakers; E, concave; F, cob-cutting knife; G, regulating slides; H, grinding plates; I, release lever; J, plate-adjusting crank.

The grinding mechanism shown in Fig. 584 is designed to grind corn in the husk and is provided with spiral knife rolls which cut against the cutter bar in the center, cutting the cobs and husks into small pieces. This mill will also grind shelled corn, small grains, and grain sorghums without additional equipment.

619. Safety Devices.—Often when grinding feed, foreign material is present in the form of sticks, bolts, nuts, and stones, which would likely

injure some part of the mill. An automatic safety release should be provided to permit the burrs to separate. The concaves are usually provided with wood break pins. Some machines have a driving gear

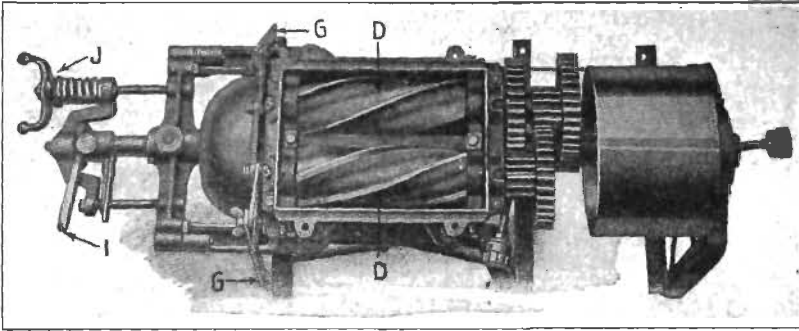


FIG. 584.—Grinding mechanism of type-D feed grinder: *D*, cob-cutting knives; *G*, feed-regulating slides; *I*, plate-release lever; *J*, plate-adjusting crank.

held by a wood break pin. The compression spring holding the plates together will give and allow the obstruction to pass through if it is rather small.

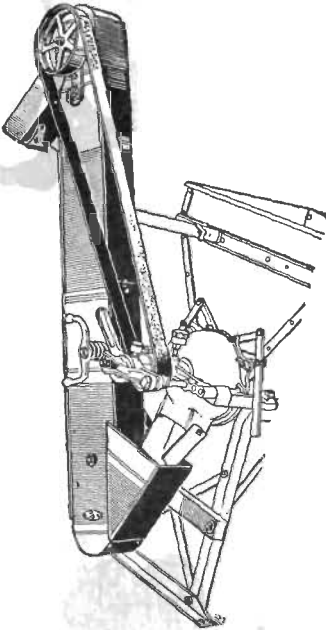


FIG. 585.—Sacking elevator attached to grinder.

620. Capacity and Power.—The capacity of burr grinders depends directly upon the diameter of the plates, the kind of material being ground, the fineness of grinding, and the speed. Bruhn,¹ states that to obtain high grinding efficiency in the small burr-type mills, the speed must be high and the rate of feeding must be regulated to eliminate crowding of the burrs. To do this, the mill should be equipped with a feeding device. The average capacity in bushels per hour is about 2 to 3 bushels for each horsepower required.

621. Bagging Attachment.—Figure 585 shows a burr mill equipped with a short elevator and spout for bagging the ground feed. Elevators suitable for elevating the feed into a wagon box are also available.

HAMMER MILLS

The hammer mill differs from the burr mill in that instead of flat disk plates, for grinding, there are hammer-like projections mounted on a

¹ *Agr. Eng.*, Vol. 17, No. 3, p. 161, 1936.

cylinder (Fig. 586). This cylinder of hammers revolves at a high rate of speed and grinds the material by beating it to pieces. It is claimed that this type of mill will grind almost any material that is used for feed.

Krueger¹ gives the following advantages of a hammer mill:

1. It is not dulled by running empty.
2. Foreign material in the feed will not ordinarily injure it.
3. There is greater range in fineness.
4. Replacements are fewer.
5. Wear does not impair its efficiency.

622. Hammers.—The hammers are fastened on a rotor or cylinder and may be rigid or swinging. The swinging hammer is hinged, but the rigid is fastened to a rotor shaft or cylinder by jam nuts. The shape of the hammer cutting edge varies according to the ideas of the designers. The hammer should, however, be made of high-grade hardened steel to prevent excessive wear.

623. Screens.—Most machines have the lower half of the cylinder enclosed by a screen usually of one piece. It may consist of holes

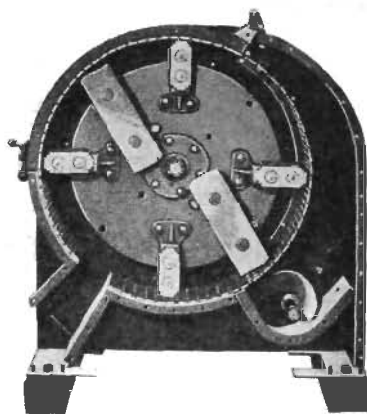


FIG. 586.—Hammer mill equipped with cutter knives and reversible swinging hammers. The mill is fed at the side of the housing.

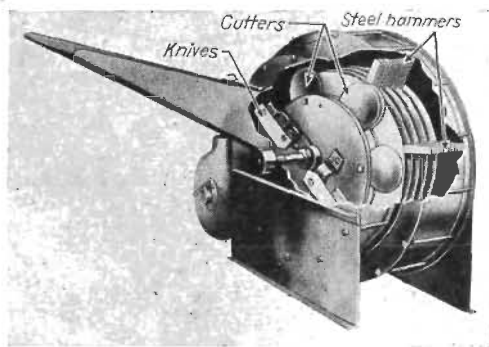


FIG. 587.—Hammer mill equipped with swinging hammers, cutters, and knives. This mill is fed through the side of the rotor housing instead of directly into the hammers.

punched through sheet steel, as shown in Fig. 588. Various size holes are used, depending upon the fineness of grinding. The size of the holes ranges from $\frac{5}{64}$ inch to 2 inches. The smaller holes are used when grinding grains, while the larger sizes are used when grinding roughage, such as sorghum stalks, cornstalks, or hay.

¹ *Agr. Eng.*, Vol. 8, No. 7, p. 167, 1927.

TABLE XXI.—CAPACITY AND HORSEPOWER REQUIREMENTS OF HAMMER MILL IN GRINDING DIFFERENT FEEDS AT DIFFERENT SPEEDS¹

Specifications:

Type—double reduction with knives and flexible hammers.

Width of grinding cylinder—8¾ inches.

Width of screen—8¾ inches.

Diameter of grinding cylinder—31½ inches.

Recommended speed—1,800 r.p.m.

Special equipment—fan-type bagger with dust collector.

Weight—970 pounds.

Size of screen, in.	Mill speed, r.p.m.	Lb. ground per hour	Kw.-hr. per 100 lb.	Power input to motor, kw.	Hp. required by mill	Fineness modulus
No load						
	1590	(Without fan)		2.24	2.00	
	1590	(With fan)		2.78	2.60	
	1930	(Without fan)		2.90	2.80	
	1930	(With fan)		3.80	3.90	
	2425	(Without fan)		4.94	5.25	
	2425	(With fan)		6.85	7.60	
Snapped corn						
½	1514	1324	0.70	9.25	10.10	3.75
Bundled Hegari						
¼	1540	1012	0.97	9.82	10.60	3.10
½	1545	1398	0.61	8.55	9.42	3.28
1	1568	1670	0.46	7.54	8.32	3.92
Alfalfa hay						
¼	1548	1401	0.55	7.73	8.56	2.41
½	1581	1363	0.46	6.09	6.70	
1	1578	2272	0.28	6.29	6.95	2.95

NOTE: Century motor used in all tests.

¹ Report of Farm Electrification Short Course at the Agricultural and Mechanical College of Texas, 1931.

624. Grinding Process.—The material to be ground is fed directly into the compartment where the hammers are revolving. The hammers strike the material with such violent force that it is practically exploded. The material is retained on the screen until it is beaten fine enough to pass through the perforations.

625. Capacity and Power.—The capacity of a hammer mill also depends to a large extent upon the rate of feeding, speed of hammers, power available, kind of material being used, fineness of grinding, size of opening in screen, and size of mill.

Table XXI shows the results of tests made by Jones of the Agricultural and Mechanical College of Texas on a hammer mill similar to the one

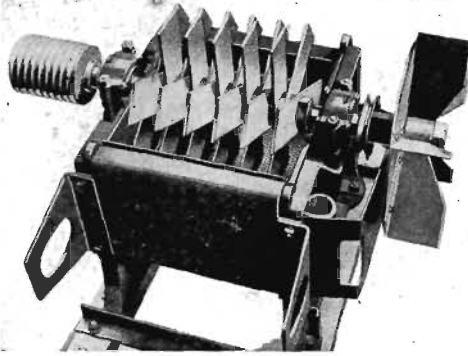


FIG. 588.—Hammer mill with rigid hammers and elevator fan.

shown in Fig. 587. Vutz¹ states that the capacity for a given fineness and horsepower is limited by the size of the screen.

626. Bagging Attachment.—Figure 590 shows an elevator and bagging attachment mounted on the mill. The ground feed is removed from under the mill by suction and blown into the large hopper of the sacking attachment. This eliminates most of the dust resulting from the grinding of the feed.

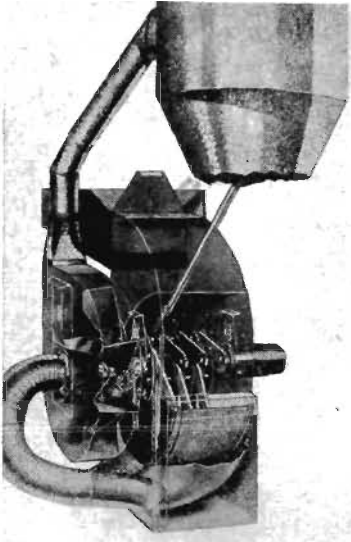


FIG. 589.—Hammer mill equipped with swinging hammers and elevator fan.

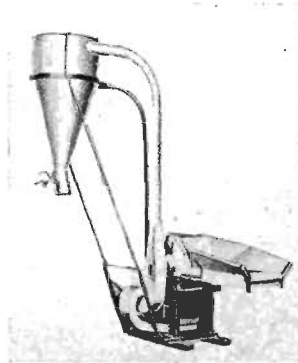


FIG. 590.—Hammer mill equipped with two-way bagging attachment elevated so feed can be run into a wagon or truck.

THE COMBINATION GRINDER AND ROUGHAGE CUTTER

The combination feed-grinder mills have some form of cutter head and may have either burrs or hammers for the final grinding of the feed. This

¹ *Agr. Eng.*, Vol. 12, No. 7, p. 271, 1931.

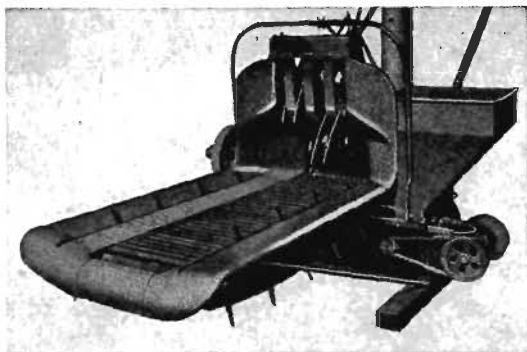


FIG. 591.—Self-feeder conveyor apron and hopper for handling roughages. An automatic governor prevents overloading of the mill.

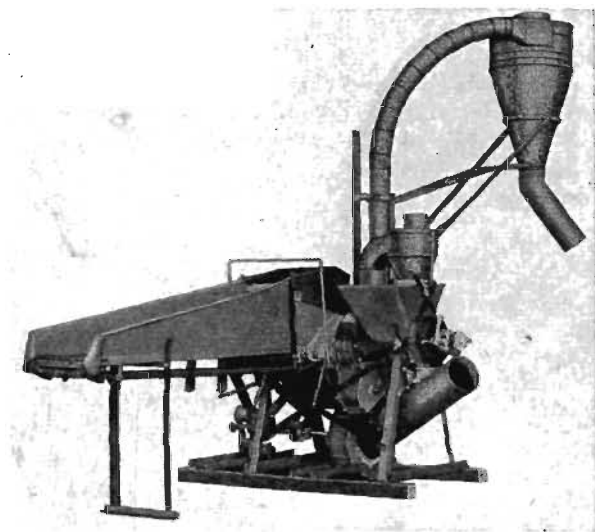


FIG. 592.—Combination roughage cutter and burr mill equipped with sacking elevator.

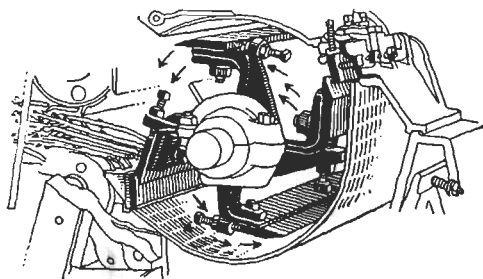


FIG. 593.—Spiral-knife cutting cylinder.

TABLE XXII.—CAPACITY AND HORSEPOWER REQUIREMENTS OF COMBINATION BURR MILL AND ROUGHAGE CUTTER

Specifications:

Type—combination knife and burr.

Width of cutting cylinder—9 inches.

Diameter of burrs—8 and 10 inches.

Recommended speed—600 to 850 r.p.m.

Special equipment—self-feed device and chain-conveyor-type sacking elevator.

Weight—1045 pounds.

Size and kind of burrs	Mill speed, r.p.m.	Lb. ground per hr.	Kw.-hr. per 100 lb.	Power input to motor, kw.	Hp. required by mill	Fineness modulus
No load						
	435			1.40	1.05	
	511			1.40	1.05	
	563			1.60	1.30	
Snapped corn						
8" coarse	410	1296	0.53	6.82	7.00*	3.98
8" coarse	419	1174	0.51	5.93	6.22*	3.88
8" coarse	520	1178	0.62	7.33	7.45*	3.56
8" coarse	675	1250	0.69	8.62	9.45†	3.55
8" coarse	790	1120	0.72	8.10	8.95†	3.34
Bundled Hegari						
8" coarse	490	893	0.65	5.81	6.15*	3.79
8" coarse	530	1083	0.46	4.96	5.33*	3.77
8" coarse	675	1100	0.51	5.58	6.10†	3.15
10" coarse	405	1023	0.65	6.60	6.82*	3.87
10" coarse	484	1435	0.50	7.05	7.78†	
Cutting only	530	1868	0.23	4.10	4.43	4.45
Alfalfa hay						
8" coarse	530	878	0.32	2.77	2.83	
8" coarse	685	867	0.55	4.70	5.02	

* General Electric motor used.

† Century motor used.

type of mill is suitable for grinding concentrates and roughages separately or in combination. The hammer mills shown in Figs. 586 and 587 are capable of cutting and grinding roughage feeds. Figure 592 shows a combination burr mill and roughage cutter.

The process of grinding hay or stalk roughage starts with the chopping up of the material by the cutter, as shown in Figs. 593 and 594. The chopped material

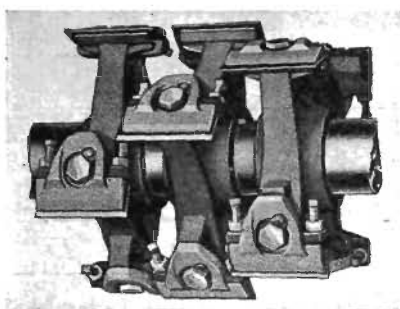


FIG. 594.—Staggered-knife cutting cylinder.



FIG. 595.—Separating and elevating system on combination feed grinder.

can be either run out as chopped feed or it can be run through the burrs and ground into meal. If desired, the concentrates such as corn, sorghum, wheat, or oats can be ground between the burrs and mixed with the chopped roughage as a complete feed. Table XXII shows the results of tests made by Jones of the Agricultural and Mechanical College of Texas on a small combination burr mill and roughage cutter.

CHAPTER XXXI

SILAGE CUTTERS

The use of the silo in which to preserve green feeds has created a demand for a machine to cut the material into short lengths and deliver it inside the silo. The silage cutter is a very efficient machine to perform this task. It is also called an *ensilage cutter* or *silo filler*.

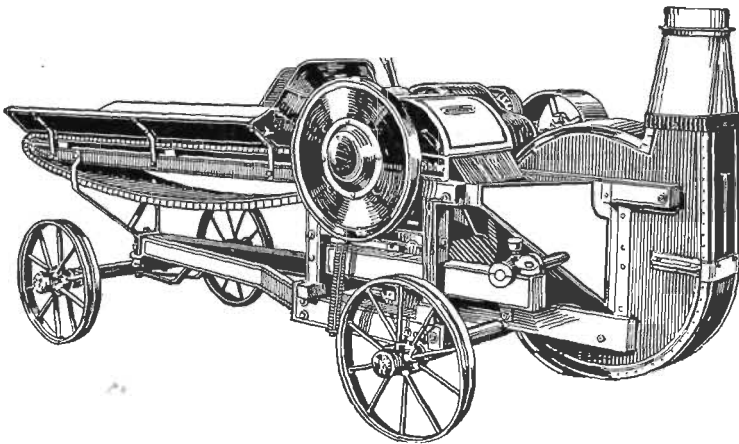


FIG. 596.—Cylinder-type silage cutter.

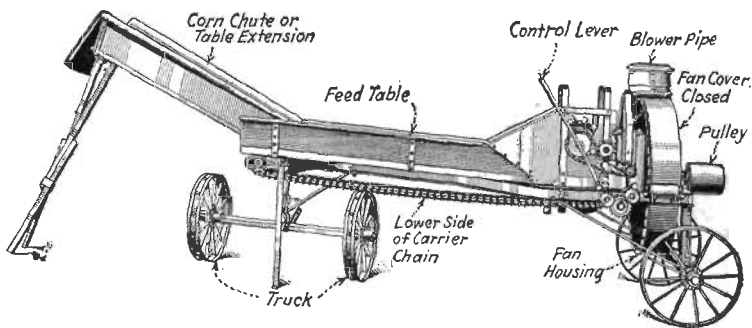


FIG. 597.—Flywheel-type silage cutter with corn chute.

627. Types.—Silage cutters may be divided into two general types, depending on the form of the cutting head. They are the cylinder type (Fig. 596) and the flywheel type (Fig. 597). A third type cuts the silage in the field and elevates it into a wagon, where it is taken to the silo and reelevated into the silo.

Both the cylinder and flywheel types are mounted on trucks so they can be easily moved from place to place. Means are provided for blowing the cut material into the inside of the silo, through a vertical blower pipe. Three distinct operations are performed by the silage cutter: feeding, cutting, and elevating.

628. Size and Capacity of Cutters.—Duffee¹ has collected considerable data to show that the capacity of a silage cutter is directly proportional to the total area of the throat opening, other things remaining the same. Some companies are now rating the size of their cutters upon the basis of the total number of square inches in the throat opening.

The formula derived by Duffee to determine the capacity of a silage cutter is as follows:

Capacity in tons per hour equals:

$$W \times H \times L \times N \times R \times K,$$

where W = width of throat, in inches measured at narrowest point.

H = height of throat, in inches.

L = length of cut expressed decimally.

N = number of knives.

R = speed, in revolutions per minute.

K = a constant of 0.00036.

FEEDING APPARATUS

The proper way to feed a silage cutter is to keep an even stream of material going through the machine at all times. It is always best to feed the stalks into the machine, butts first.

The feeding mechanism of a silage feeder consists primarily of the apron and the feed rolls. Some of the smaller cutters do not have a carrier apron but are hand fed.

629. Feed Apron.—There are several types of traveling aprons. On some machines *grip hooks* are used to make the feeding more positive. Figure 598 shows a typical feed apron. Both metal and wooden slats are used. Metal is considered the best. A tension device is provided to regulate the tightness of the apron.

630. Corn Chute.—Where the bundles are being thrown on the feed apron directly from the wagon, the *corn chute* or *extension table* (Fig. 597) is of great help. The bundles can be lapped sufficiently to materially aid in feeding.

631. Feed Rolls.—The feed rolls receive the green material from the apron and present it to the cutting mechanism. The rolls have different shaped surfaces, such as corrugated, fluted, and toothed. The number of rolls in a machine vary from two to four. The top rolls should be

¹ *Am. Soc. Agr. Eng. Trans.*, Vol. XIX, p. 102, 1925.

adjustable vertically, yet have tension enough to assure positive feeding. Tension is provided either by weights or by springs.

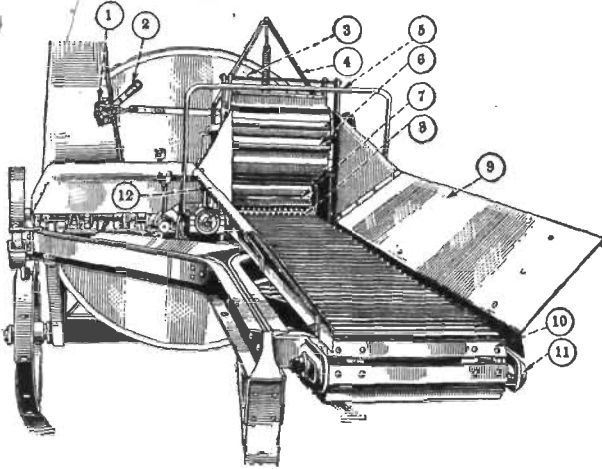


FIG. 598.—Carrier apron and feed rolls: 1, 2, lock for cover; 3, fan cover; 4, spring yoke; 5, clutch and control lever; 6, paddle feed roll; 7, upper feed roll; 8, lower feed roll; 9, table side; 10, carrier slat; 11, adjustment for carrier tension.

Duffee found in his investigations on silage cutters that better and more positive feeding was obtained by having the conveyor apron and the surface of the feed rolls travel at the same rate of speed.

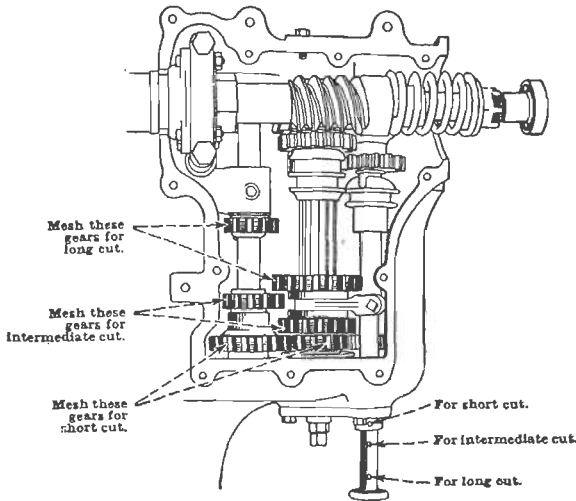


FIG. 599.—Method of changing length of cut.

632. Length of Cut.—It is often desirable to change the length of cut on silage cutters. The most common lengths for silage ranges from $\frac{3}{8}$ to $\frac{1}{2}$ inch. The length of cut is regulated by the speed of the feed apron

and the feed rolls. Feeding faster will give longer cuts while slower feeding will give shorter cuts.

The speed is changed by changing the gear or sprocket wheel that drives the feeding mechanism (Fig. 599).

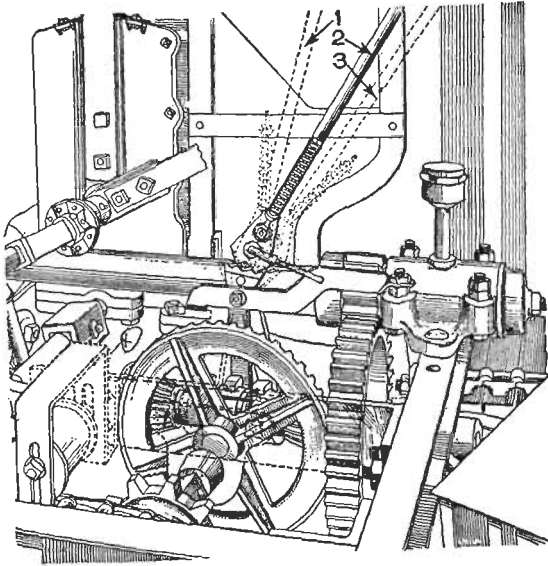


FIG. 600.—Feed control lever: 1, reverse position; 2, neutral position; 3, forward position.

633. Feeder Control.—Figure 600 shows a control lever for the feeding mechanism in forward, neutral, and reverse positions. Position 3 is forward or cutting position. Figure 598 shows a lever control that is convenient to both sides of the machine. This provides a safety device since falling against the lever would throw the machine into neutral or reverse position.

CUTTING MECHANISM

The cutting mechanism consists of the cutting head, of which the most important parts are the knives and the *shear plate* or *cutter bar*. There are two types of cutter heads: cylinder and flywheel.

634. Cylinder-type Cutting Head.—Figure 601 shows the cutting head of the cylinder type. The number of knives vary from one to four. They are curved spirally to form a cylinder. The construction is similar to the cutting head of a lawn mower, except that it is larger and heavier.

The cutting head of the cylinder type is entirely separate from the blower. It may be mounted on separate shafts or it may be on the same shaft, as shown in Fig. 602. When the material has been cut by the knives, it is delivered to the blower by gravity or by an auger con-

veyor. The speed of the cutting head is from 500 to 600 revolutions per minute.

The blower, when a separate unit, runs at a speed of 500 to 1,000 revolutions per minute.

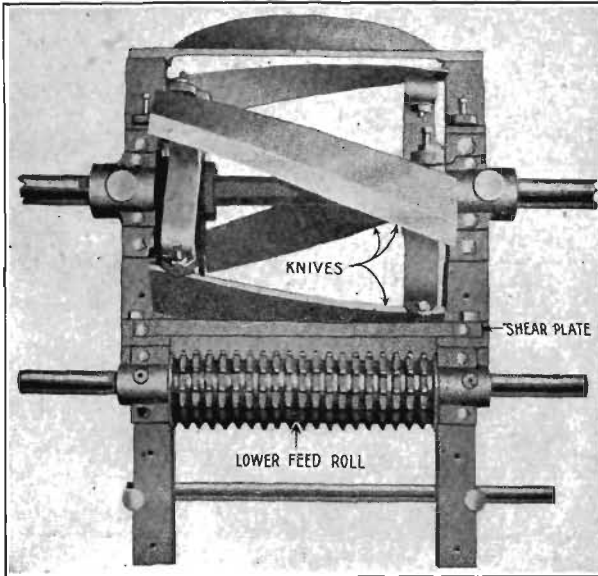


FIG. 601.—Overhead view of cylinder cutter head, shear plate, and lower feed roll.

635. Flywheel Type.—The cutting head of the flywheel type consists of a steel or cast-iron flywheel on which are fastened the knives and fan blades (Fig. 603). If the wheel is made of cast iron, it should be rein-

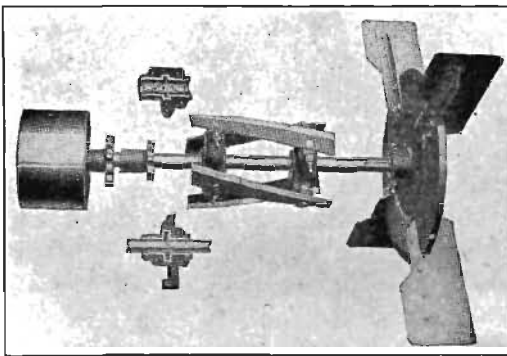


FIG. 602.—Cylinder cutting head, fan, and pulley mounted on the same shaft.

forced by a steel band or tire around the rim. When a cast-iron wheel is operated at a high speed, there is danger of its exploding or being pulled to pieces, owing to centrifugal force. Under no circumstances should the

blower fan housing be opened while the machine is running. Wait until it stops and thus avoid a serious accident. Steel wheels are much safer than cast-iron wheels.

The shape of the knife used may be either straight, concave, or convex. The straight knife is most often used.

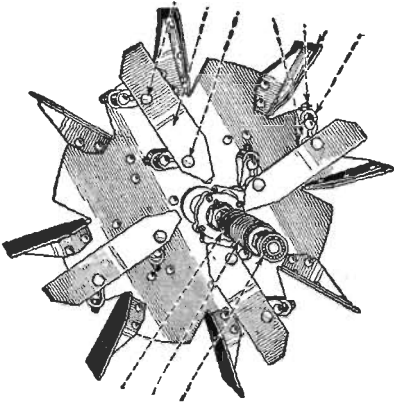


FIG. 603.—Flywheel cutter head showing knives and fan blades.

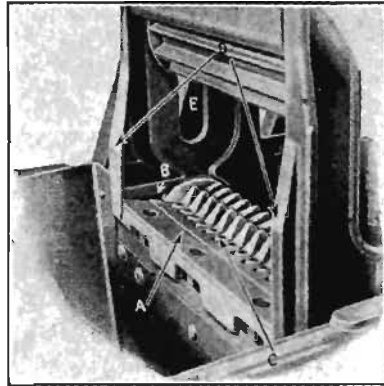


FIG. 604.—Shear plate A, and feed roll B, for flywheel silage cutter.

The speed of the cutting head in the flywheel-type cutter is much higher than that of the cylinder type. It ranges from 600 to 1,000 revolutions per minute.

636. Shear Plate.—The shear plate is also termed the *cutter bar*. This plate, as shown in Fig. 604, forms the other cutting edge for the knives. Some bars are reversible and may have as many as four cutting edges.

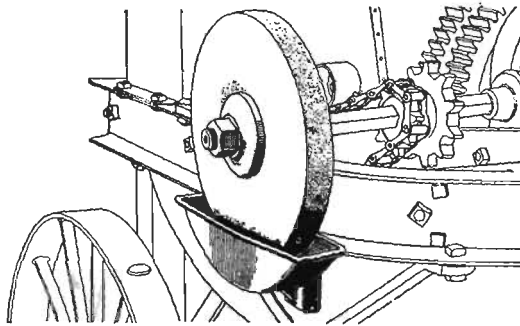


FIG. 605.—Knife-grinding attachment for silage cutter.

637. Knife Adjustment.—Both the cylinder and flywheel types are provided with means whereby the knives can be adjusted to the shear plate. This is done by setscrews and wedges that act on the knife. Additional adjustments may be made with setscrews to line up the

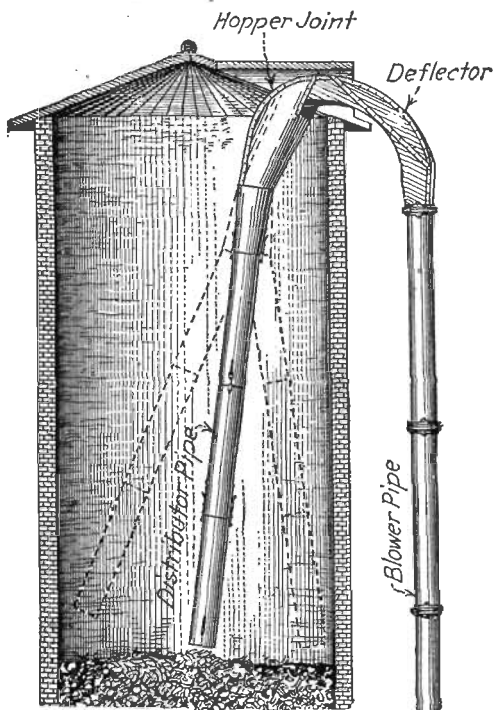


FIG. 606.—Blower and distributor pipe.

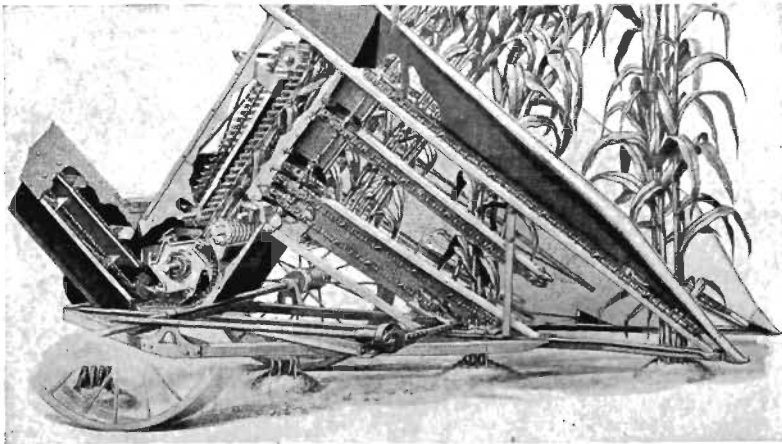


FIG. 607.—Sectional view of silage harvester showing harvesting, feeding, cutting, and elevating mechanism.

whole cutter head. For the best cutting the knife should work just as close as possible to the shear plate without striking.

638. Sharpening Knives.—It is very essential that the knives be kept sharp. As a general rule, they should be sharpened after each half-day's work. Figure 605 shows a knife-grinding attachment placed on the machine.

ELEVATING SILAGE

There are two methods of elevating cut silage into the silo: the carrier elevator and the blower. The majority of cutters use the blower.



FIG. 608.—Field silage cutter drawn and driven by a tractor. The truck catches the cut silage.

The cylinder type has a blower fan separate from the cutting head while in the flywheel type the fan *blades* or *wings* are mounted on the wheel between the knives. These blades should fit the fan housing rather closely to obtain efficient elevation.

639. Blower and Distributor Pipe.—The blower pipe should be set as nearly vertical as possible. If the pipe has very much of an angle, the heavy silage will gravitate to the lower side and let the blast of air pass over and above it. Such a condition would soon cause the pipe to choke. Figure 606 shows a part of the blower pipe with the deflector hood, hopper, and several sections of the distributor pipe. The deflector hood deflects the silage over into

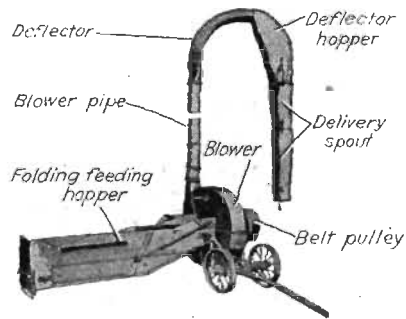


FIG. 609.—Blower for elevating silage into silo.

TABLE XXIII.—DATA ON 1925 SILO FILLER TESTS CONDUCTED BY THE AGRICULTURAL ENGINEERING DEPARTMENT, COLLEGE OF AGRICULTURE, UNIVERSITY OF WISCONSIN⁶

No.	Type, flywheel or cylinder	Height of silo, feet	Size of cutter, inches	Length of cut, inches	Cutter speed, revolu- tions per minute	Fan speed, revolu- tions per minute	Tons, per hour	Aver- age horse- power	Horse- power hours, per ton
1	Flywheel	30	11	0.482	666	.....	12.92	18.91	1.461
2	Flywheel	30	11	0.482	764	.....	12.86	20.60	1.601
3	Flywheel	30	11	0.482	758	.....	14.00	22.47	1.605
4	Flywheel	30	11	0.482	937	.....	14.95	26.66	1.784
5	Flywheel	30	11	0.482	923	.....	16.97	30.70	1.810
6	Flywheel	30	13	0.586	525	.....	16.76	15.27	0.910
7	Flywheel	30	13	0.586	654	.....	20.34	24.20	1.190
8	Flywheel	30	13	0.586	779	.....	23.22	33.20	1.430
9	Flywheel	53	13	0.413	571	.....	11.72	13.25	1.130
10	Flywheel	53	13	0.413	766	.....	16.51	18.23	1.104
11	Flywheel ¹	37	14	0.481	400	.....	19.62	15.15	0.772
12	Flywheel ¹	37	14	0.481	505	.....	17.52	16.91	0.965
13	Flywheel ¹	37	14	0.481	512	.....	18.88	19.53	1.033
14	Flywheel ¹	37	14	0.481	496	.....	21.78	20.30	0.932
15	Flywheel ²	53	14	0.481	443	.....	14.04	12.95	0.922
16	Flywheel ²	53	14	0.481	442	.....	17.75	16.95	0.954
17	Flywheel ³	37	14	0.481	392	.....	18.40	14.50	0.788
18	Flywheel ³	37	14	0.481	400	.....	24.83	20.95	0.844
19	Flywheel ³	37	14	0.481	451	.....	16.28	14.14	0.868
20	Flywheel ³	37	14	0.481	496	.....	23.97	22.82	0.952
21	Cylinder ⁴	53	14	0.500	1,166	1,166	14.64	19.29	1.317
22	Cylinder ⁴	53	14	0.500	1,142	1,142	15.12	20.70	1.368
23	Cylinder ⁴	53	14	0.500	1,156	1,156	11.00	14.80	1.345
24	Cylinder	37	75 (sq. in.)	0.578	447	776	18.80	17.95	0.955
25	Cylinder	37	75 (sq. in.)	0.578	444	770	20.36	20.05	0.985
26	Cylinder	37	75 (sq. in.)	0.578	456	790	15.54	15.91	1.024
27	Cylinder	37	75 (sq. in.)	0.578	440	762	24.20	23.96	0.990
28	Flywheel	53	13	0.458	529	.....	16.90	12.89	0.762
29	Flywheel	53	13	0.458	535	.....	13.42	12.37	0.922
30	Flywheel	53	13	0.458	635	.....	18.60	20.18	1.084
31	Flywheel	53	13	0.458	637	.....	16.60	17.17	1.035
32	Cylinder	37	70 (sq. in.)	0.350	469	547	14.60	13.05	0.894
33	Cylinder	37	70 (sq. in.)	0.350	473	552	14.35	13.51	0.941
34	Cylinder	37	70 (sq. in.)	0.350	564	658	17.18	20.47	1.191
35	Cylinder	37	70 (sq. in.)	0.350	570	664	15.37	17.30	1.125

NOTE.—The 53-foot silo for Tests 9 and 10, 15 and 16, 21 to 23, and 28 to 31 would increase the power requirement probably 3 per cent.

¹ A special Case cutter with four knives and eight fan wings instead of three knives and six fan wings. The fan wings used in this test had considerable clearance. Regular knife supports were used.

² Same as 1 except that the fan wings were close fitting.

³ Special Case machine with four knives and eight fan wings. Special cast-iron spider knife support.

⁴ Special Case machine with two knives and four fan wings.

⁶ *Am. Soc. Agr. Eng. Trans.*, Vol. XX, p. 101, 1926.

the silo. As the silo is filled, sections of the distributor pipe can be removed until the top is reached.

640. Relation of Capacity and Power Requirements.—Table XXIII shows the results obtained by Duffee in his tests of silage cutters. The type of machine, height of silo, size of cutter, length of cut, cutter-head speed, fan speed, tons per hour, average horsepower required, and the horsepower hours per ton are all shown.

641. Silage Harvesters.—Two units are necessary to fill a silo when the silage is prepared in the field: a field unit and a silo unit. The field unit consists of a power-driven harvester similar to the corn binder and is composed of divider boards, gathering chains, side knives and sickle, and packers to feed the harvested corn to the cylinder cutterhead which cuts the corn into suitable lengths for silage (Fig. 607). The cut silage is elevated into a wagon or truck that travels along under the elevator (Fig. 608).

The blower consists of a feedbox, a fan, and the usual blower and distributor pipe (Fig. 609).

PART XI FERTILIZING MACHINERY

CHAPTER XXXII

MANURE SPREADERS

The manure spreader is a machine for carrying barnyard manure to the field, tearing it up, and spreading it uniformly over the land

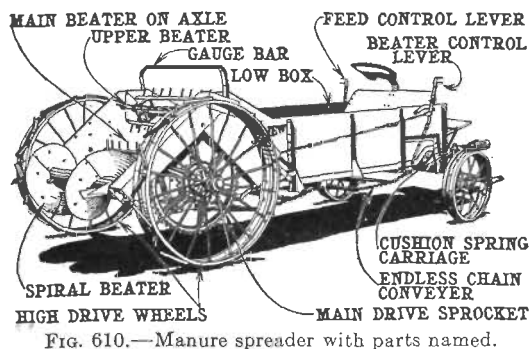


Fig. 610.—Manure spreader with parts named.

(Fig. 610). This type of machine should be on every farm that produces several tons of manure per year. It is a successful machine and is a paying one because it will save labor by spreading the manure faster and more uniformly than can be done by hand.

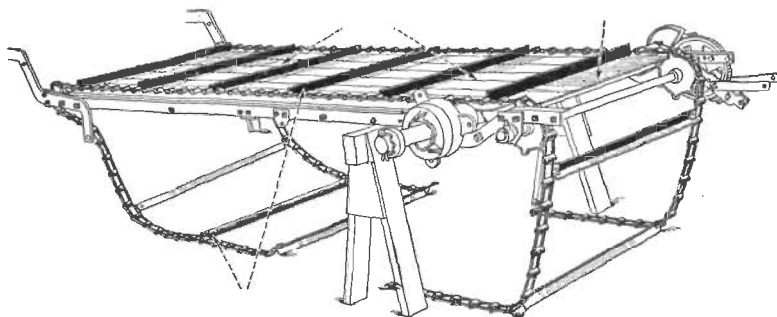


Fig. 611.—Frame and tight bottom with conveyer.

642. The Frame.—Since manure is very heavy and at least a ton is loaded on the spreader for each trip to the field, it requires a substantial,

yet comparatively light, frame. The side rails on all spreaders should be made of a good grade of channel steel properly reinforced and braced. Figure 611 shows a typical frame with the conveyor attached.

CONVEYORS OR APRONS

The quantity and the uniformity of spreading depend to a great extent upon the proper operation of the conveyor or *apron*. It carries

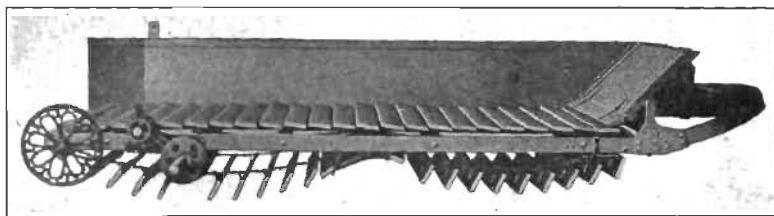


FIG. 612.—Endless apron or conveyor with slats hinged to allow cleaning.

the manure back to the rear of the machine, sliding it over the bottom, where it comes in contact with the beaters. There are three types of conveyors, or aprons: the reverse, the endless, and the tight bottom with conveyor.

643. Return Apron.—This type of apron is now practically obsolete on manure spreaders.

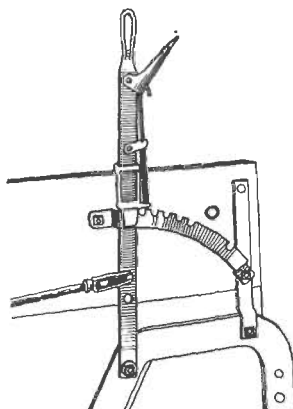


FIG. 613.—Showing the feed lever in high speed. Pushing lever ahead to last notch throws machine out of gear.

644. Endless Apron or Conveyor.—A few spreaders are still equipped with the endless type of conveyor. Many manufacturers, however, are discontinuing its use. Figure 612 shows an endless apron which is self-cleaning because the slats hinge on one side and hang down, allowing any material that might have dropped through the top part of the conveyor to pass between the slats.

645. Tight Bottom with Conveyor.—This type of apron, which is now practically standard on spreaders, consists of a stationary solid wooden bottom, over which slides an endless web chain of steel slats. Figure 611 shows the conveyor chain in position on the tight bottom of the box. The manure is thrown into the box on the conveyor which is stretched over the bottom of the box. Then, as the conveyor moves to the rear, it slides and carries the manure with it.

All types of aprons operate very slowly. The minimum travel per revolution of the main drive wheel is about 1 inch, while the maximum is around 3 inches.

The rate of travel is controlled by a lever (Fig. 613) placed convenient for the driver. From 5 to 20 loads can be spread per acre.

The tension of the conveyor chain can be adjusted by a setscrew arrangement on each end of the front conveyor shaft.

646. Conveyor Drive.—A ratchet and pawl arrangement is the standard device for driving the conveyor chain or apron of a manure spreader. Figure 614 shows three typical conveyor drives. As the feed cam raises the rocker arm, it causes the feed pawl to engage the teeth on the ratchet wheel and turn it. The number of teeth engaged by the feed pawl

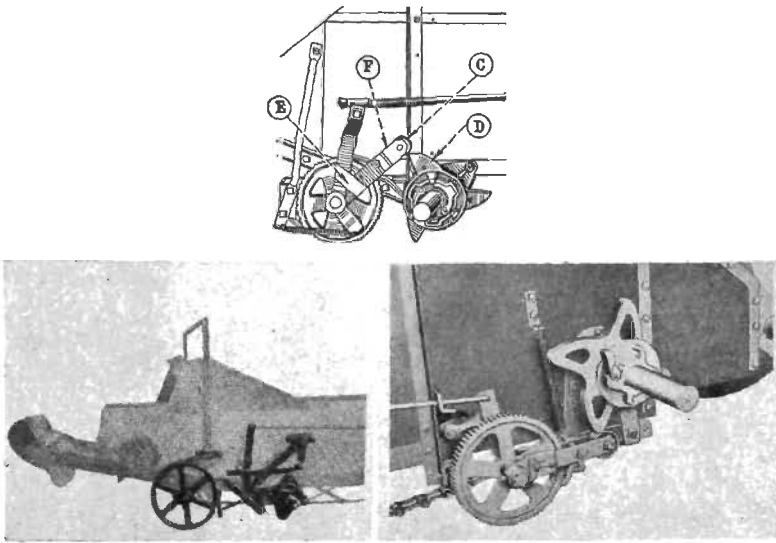


FIG. 614.—Three conventional types of conveyor drives.

at a stroke is regulated by a stop pawl. This in turn regulates the speed of the conveyor and the volume of manure distributed. The adjustment of the feed pawl is controlled by a lever placed convenient for the driver. The lever is connected to the feed pawl by a long rod and can be shifted to any position without stopping the machine.

647. Beater.—The beater is placed just to the rear of the conveyor to beat, tear up, and spread the manure from the rear of the spreader (Fig. 615). It must be made substantial because it must spread all kinds of manure in various states of physical condition. There should be good substantial bearings of self-aligning or roller type. The beater may have either wood or steel bars through which the teeth are fastened. Some teeth are riveted in, while others are held in place by nuts.

The beater revolves in the opposite direction to that of the main wheels. It is, therefore, necessary to have some arrangement to give it this reverse motion. These methods will be discussed under beater

drives. The beater should revolve at a comparatively high rate of speed and the ratio is usually about 6 or 7 to 1, that is, a beater revolves about seven times to the main wheel once.

If the beater is made the same diameter from one end to the other, more manure is likely to be spread behind the center of the spreader than to the sides, because, in loading, the load is piled higher in the middle of the box than at the sides. It is also packed more compactly in the center.

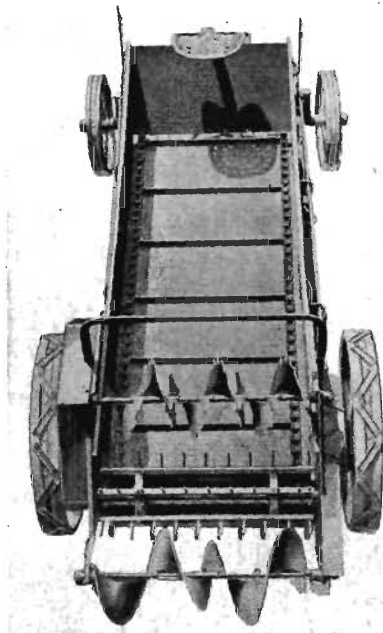


FIG. 615.—Overhead view of manure spreader showing tight-bottom conveyor, main and auxiliary beaters, and wide spread.

To offset this some companies have made beaters which are divided at the center and made in two sections. The center part of the beater is larger than that of the outside. Others have a beater made in a circular shape. This type of construction prevents more manure being spread directly behind the center of the spreader than to the sides.

648. Auxiliary Beater.—On many manure spreaders there is an auxiliary beater placed above and a little to the front of the main beater (Fig. 615). This auxiliary beater aids the main beater in tearing up and pulverizing the large flakes that are encountered. It receives its power directly from the main beater shaft by means of a chain passed around a sprocket of the main beater shaft and the auxiliary beater shaft. It revolves in the same direction, therefore, as that of the main beater.

649. Widespread Device.—To prevent the manure being spread thicker behind the center of the machine, a widespread device is used (Fig. 615). It will also spread the manure wider than the machine and makes it unnecessary to lap the loads. The device consists of steel blades or a curved spiral. One-half of the spiral is set to throw to the left, while the other half is set to throw to the right.

The manure is thrown backward by the beaters against the revolving spirals, which throw it backward and outward and spread it uniformly over a width of about 7 or 8 feet. The widespread beater is driven by a chain from the main or auxiliary beater shafts.

650. Beater Drive.—The chain is the common method of driving the beaters on manure spreaders. A large drive sprocket is mounted

rigidly on the main axle. The drive chain passes around a sprocket on the end of the auxiliary beater shaft or main beater shaft, and around a movable idler sprocket (Fig. 616). The chain does not pass around the drive sprocket. As the movable idler sprocket is lowered, the bottom part of the drive chain is lowered onto the drive sprocket. This will cause the beaters and widespread device to turn in the opposite direction to that of the main drive sprocket. The machine is thrown out of gear by raising the drive chain from the drive sprocket. This is done by a

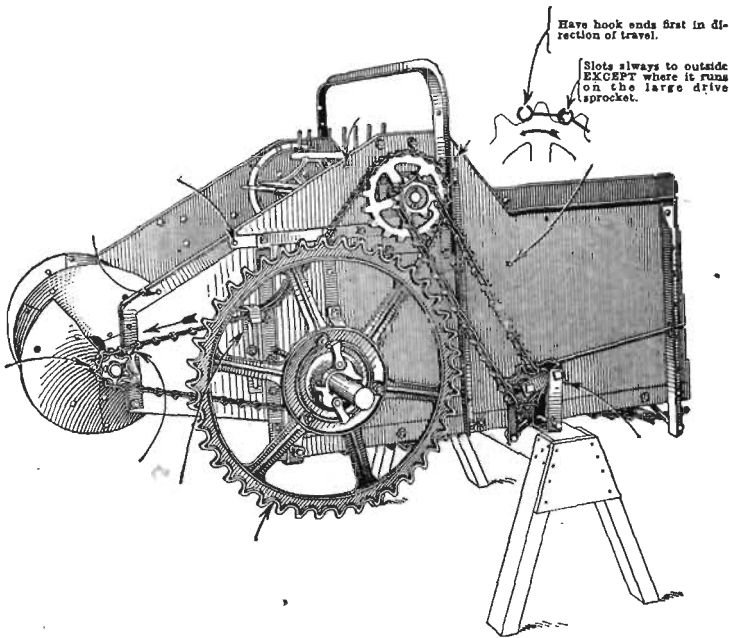


FIG. 616.—Beater drive. The main beater on this spreader is on the rear axle.

control lever placed on the front of the box and connected to the idler sprocket by a rod.

651. Box.—An interior view of the box is shown in Fig. 615. The box of the standard spreader has a tight wood bottom with side boards to hold the manure. The box should be about 1 to 1½ inches wider at the rear than at the front so the manure will not wedge between the side boards as the conveyor carries it to the rear of the machine.

The front end gate is inclined forward so the manure can be heaped up. As the load moves backward, the manure will fall forward and level out.

A rear end gate, as shown in Fig. 617, prevents the manure packing against the beaters while on the way to the field. It makes the beaters easier to start. Soft wet manure will not leak out at the rear with an end gate.

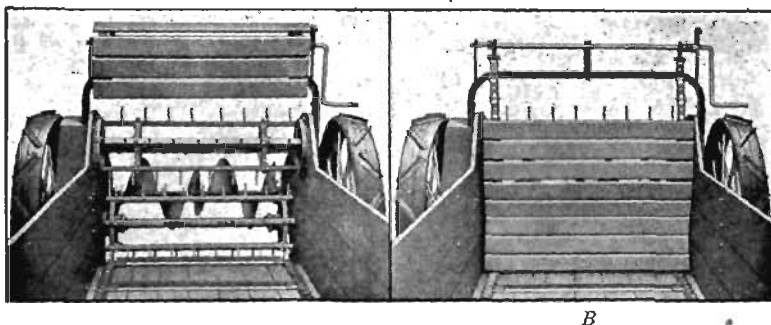


FIG. 617.—Rear end gate for manure spreader: *A*, end gate raised, in spreading position:
B, end gate lowered, in loading position.

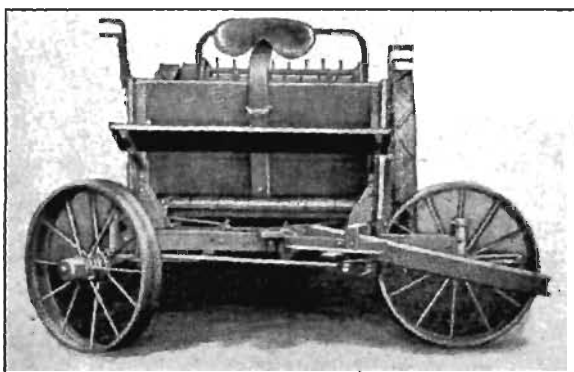


FIG. 618.—Front truck wheels remain parallel when turning.

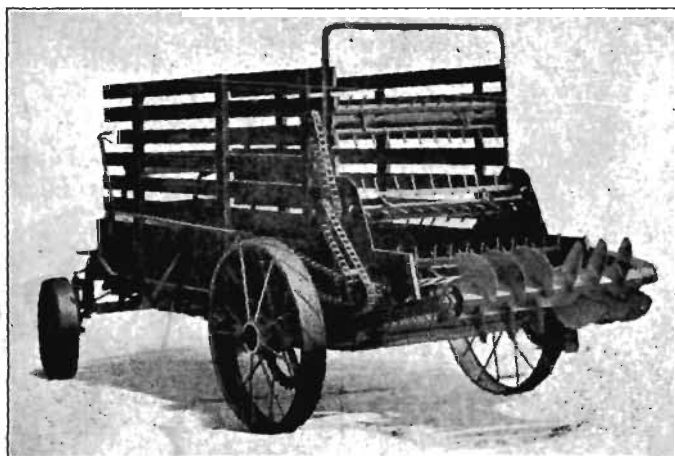


FIG. 619.—Straw-spreader attachment.

652. Front Trucks.—The old-type fifth-wheel farm-wagon type of front truck is being rapidly discarded for the auto-steering arrangement. The front wheels track with the rear wheels. The front and rear wheels are the same distance apart. The front wheels are mounted upon short, pivotal, axle ends which are attached to the frame under the corner of the box by vertical spindles. Arms, extending forward from the spindles, are connected to the tongue socket by steering rods in such a manner that the wheels turn and remain parallel when the tongue is moved to either side (Fig. 618). The movement is similar to that of the front wheels of an automobile.

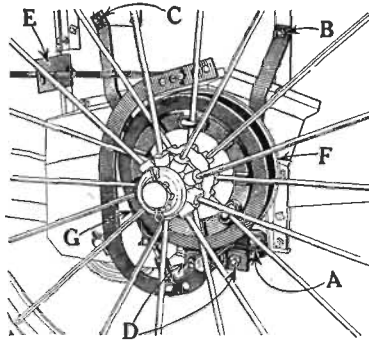


FIG. 620.—Brake attachment for manure spreaders.

This type of truck eliminates *whipping* of the tongue, when on rough ground with a heavy load.

653. Size and Capacity.—The size of a manure spreader is usually given in bushels. The average spreader will hold from 60 to 70 bushels. A dry measure bushel is equal to 2,150.4 cubic inches.

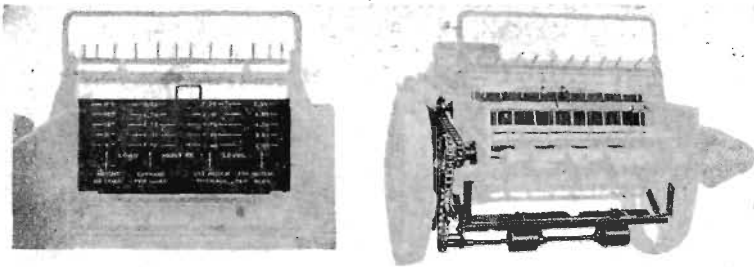


FIG. 621.—Lime-spreading attachment and end gate with scale to indicate tons when load is level, also tons per acre for lever notches.

654. Straw-spreader Attachment.—A straw-spreading attachment, similar to the one shown in Fig. 619, can be secured for most manure spreaders. Such an attachment makes it possible to take the straw from the straw stacks and spread it in a thin layer over the land so that it can be plowed in to add fertility and humus to the soil.

655. Brake Attachment.—In hilly sections a brake attachment is essential. Figure 620 shows such an attachment fastened to one of the rear wheels of a spreader.

656. Lime-spreader Attachment.—Figure 621 shows an attachment for manure spreaders to spread lime. A special end gate with a scale to indicate the tonnage and rates of application is placed in front of

the beaters until the field is reached and the load is ready to be spread, at which time it is removed (Fig. 621). The lime falls on two revolving disks, which spread it.



FIG. 622.—A two-wheel tractor-drawn and tractor-driven manure spreader equipped with rubber tires.

657. Loading the Spreader.—It is considered the better plan to start loading at the front end and finish at the rear end. The manure is torn up and broken to pieces easier when the load is put on in this manner.

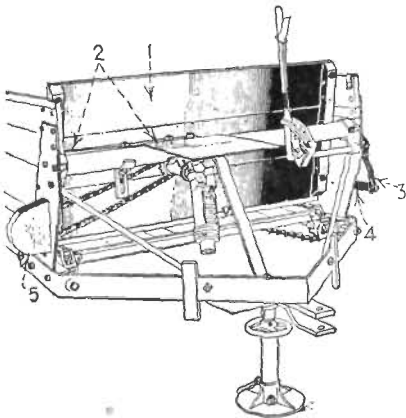


FIG. 623.—Front end of tractor manure spreader showing tractor hitch, slip-clutch drive, and main drive chain.

658. Mechanical Loaders.—When spreading manure with a manure spreader, more time is consumed in loading than any other operation. It is also the hardest work. Mechanical loaders are available whereby the manure is loaded on the spreader without having to do it with a pitchfork.

659. Tractor Hitch.—Most companies can furnish a hitch which will allow the spreader to be drawn by a tractor. Hitches can be built so that two machines can be handled by one tractor.

660. Tractor Spreaders.—Two-wheel spreaders are available, especially designed to be drawn by a tractor, and equipped with a power take-off drive to drive the conveyor and beaters (Figs. 622 and 623).

CHAPTER XXXIII

COMMERCIAL FERTILIZER DISTRIBUTORS

The use of commercial fertilizers is becoming more extensive each year. Such fertilizers are of many kinds and vary from highly concentrated chemicals, that must be used in small quantities, to a rather low-grade mixture which is used in large amounts.

The fact that a fertilizer distributor is required to distribute varying amounts of fertilizer, in almost any physical and mechanical condition, and place it in the soil so that it will not injure the seed, makes it difficult to design a machine that will meet such a wide range of requirements.

661. Location of Fertilizer in Relation to the Seed.—A committee of the American Society of Agronomy on Fertilizer Application recommended that all fertilizer attachments on planting and seeding machinery be so designed as absolutely to prevent contact between seed and fertilizer.

A joint committee on fertilizer application, representing the American Society of Agronomy, the American Society of Agricultural Engineers, The National Fertilizer Association, and the National Association of Farm Equipment Manufacturers adopted the following statement on fertilizer application:

Contact of fertilizer with the seed, except when fertilizer is used in very small amounts, tends to depress and delay germination and may even prevent it. The extent of this delay or depression varies with the materials used in the fertilizer, with the moisture content of the soil, with the crop grown, and with the quantity of fertilizer applied.

Accepting the above statements, we find that the fertilizer may be applied as hill applications with hill dropping of the seed, or drilled when the seed are drilled. Then, for the small grains, it may be either drilled or broadcasted.

When the fertilizer is placed in the soil, it may be located in relation to the seed as follows:

1. Hill:
 - a. Above seed.
 - b. Below seed.
 - c. In front of seed.
 - d. In direct contact with seed.
2. Drill:
 - a. Above seed.
 - b. Below seed.

- c. To the side and below the level of the seed.
- d. In direct contact with the seed.
- e. Mixed in row with seed.
- 3. Broadcasted before planting.
- 4. Side dressing:
 - a. On one side of plants.
 - b. On both sides of plants.

Even though it is not desirable, many fertilizer attachments for planting and seeding machinery place the fertilizer in direct contact with the seed.

662. Types of Distributors.—There are several different types of fertilizer distributors. The design of the machine is greatly influenced by the time at which the fertilizer is to be placed in the soil. It is the practice in certain sections to distribute part of the fertilizer before planting and part after the crop is well advanced, as a side dressing. Many small-grain growers like to drill or broadcast the fertilizer before planting. The bulk of the fertilizer for crop production, however, is handled by fertilizer distributing attachments on planting and seeding machinery. Applications of lime are usually broadcasted.

The types of fertilizer distributors are: the walking vibrator, the attachments for one- and two-row planters, grain drills, cultivators, and the broadcast distributors.

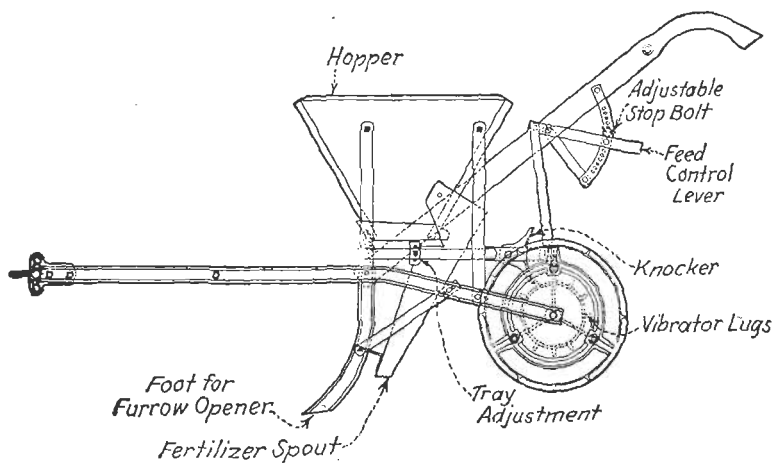


FIG. 624.—Side view of vibrator-type fertilizer feed.

663. Vibrator or Knocker Distributor.—Figure 624 shows a fertilizer distributor used to place the fertilizer in the soil before planting. It consists of a wood hopper, trapezoidally shaped, mounted on a beam, having a steel wheel at the rear and a foot for a furrow opener directly under the hopper. The hopper is hinged on the lower front edge. The rear side of the hopper is supported by an arm extending to the rear and

resting on a series of lugs on the side of the drive wheel. At the bottom of the hopper there is a tray, with an adjustable control.

The fertilizer is shaken from the hopper by vibrations caused by the knocker coming in contact with the lugs on the side of the revolving wheel.

The fertilizer may fall into a single spout and, thence, into the row or into a double spout which will deposit it as a side dressing beside two rows of plants.

FERTILIZER ATTACHMENTS FOR ROW PLANTERS

Fertilizer distributing attachments can be secured for all types of row planters.

664. For One-row Walking Planters.—One-row walking planters with fertilizer attachments are shown in Figs. 228, 625, and 626. The fertilizer

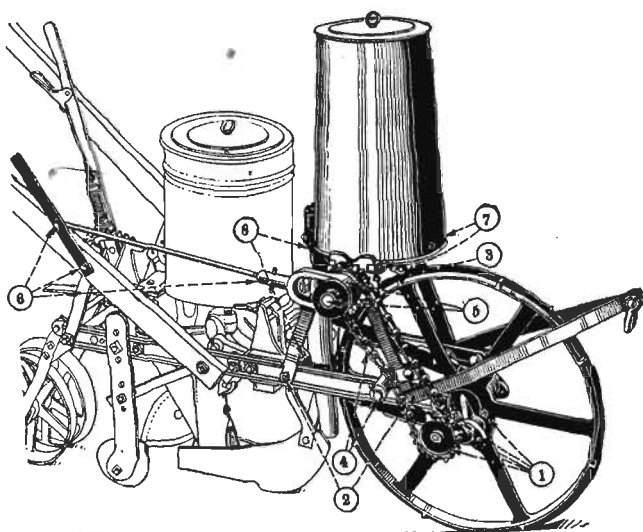


FIG. 625.- Fertilizer attachment for walking planter. The fertilizer is placed to the side of the seed.

hopper is placed to the front of the seed hopper. The feeding device is driven by sprocket and chain from the drive wheel or by the cranks attached to the pitmans that drive the planting mechanism.

The fertilizer (Fig. 625) is deposited in front of the furrow opener and partially mixed in the row above the seed.

In Fig. 626 the fertilizer is placed in a furrow and mixed in the row, below the seed.

665. For One- and Two-row Riding Drill Planters.—One- and two-row cotton and corn planters can be equipped with fertilizer attachments, as shown in Figs. 242, 244, and 627. The fertilizer hopper is

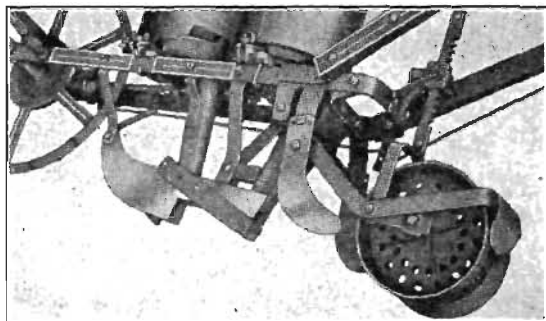


FIG. 626.—Tipover view of walking planter showing fertilizer spout, seed spout, fertilizer covering blades, runner casting, and press wheel with automatic scraper. The fertilizer is placed below the seed.

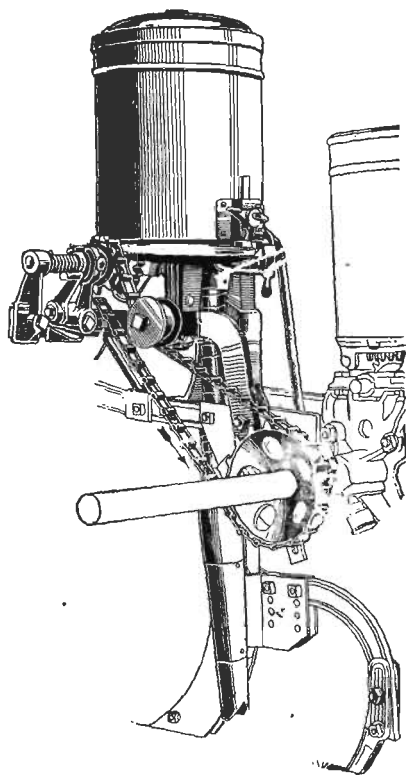


FIG. 627.—Fertilizer attachment for one-row riding cotton and corn planter. The fertilizer is mixed in the row.

mounted to the front of and slightly higher than the seed hopper. The fertilizer distributing mechanism is driven from the main axle by sprocket and chain.

The fertilizer is deposited by the feeding mechanism on the ground behind the sweep or middlebreaker and just ahead of the seed furrow opener (Fig. 627). The furrow-opener shovel plows through the fertilizer, mixing it with the soil in the row.

666. For Check-row Planters.—Where corn is checked it is desirable to place the fertilizer near the hill. The attachment shown in Fig. 628 is

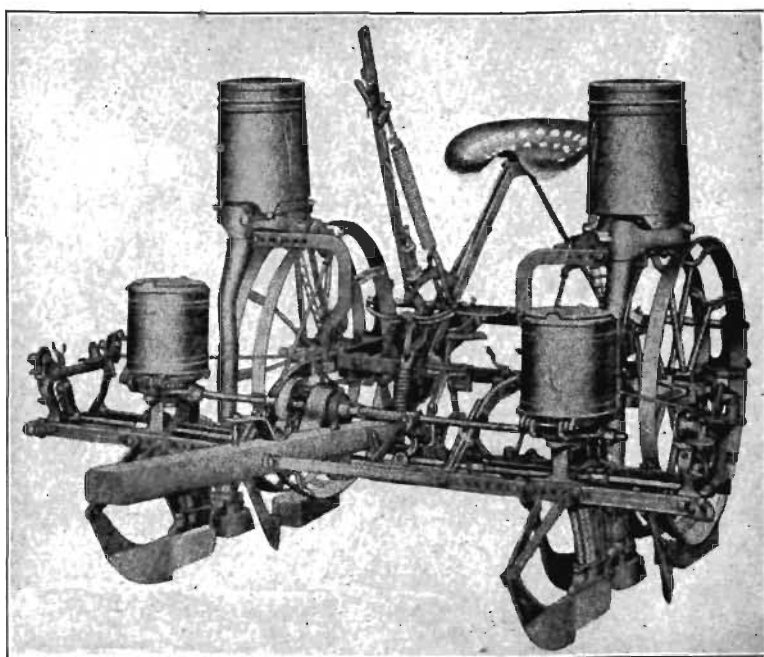


FIG. 628.—Automatic hill-dropping fertilizer attachment. The fertilizer is placed above the hill.

designed to automatically drop a quantity of fertilizer at each hill of corn.

Truog¹ recommends that a fertilizer attachment for a corn planter should be adjustable, so that quantities ranging from 75 to 200 pounds per acre may be applied in the hill. This fertilizer should be applied in a band about 4 inches wide and 8 inches long from $\frac{1}{2}$ to $\frac{3}{4}$ inch directly above the seed. The fertilizer should not be dropped in a mass, but should be spread over the whole area.

Figure 629 shows how the valve in the lower end of the fertilizer tube is opened in unison with the seed valve.

¹ TRUOG, E., *Reports and Proceedings of the Joint Committee on Fertilizer Application*.

Figures 221 and 630 show a deflector to scatter and divert fertilizer, thus preventing it from coming in contact with the seed

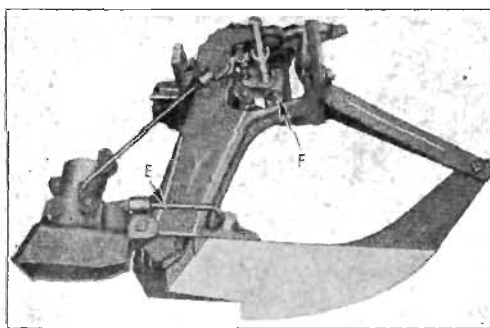


FIG. 629.— Hill-dropping fertilizer attachment that operates automatically with the dropping device of the planter.

667. For Tractor Planters.—Fertilizer attachments have been designed to fit most tractor planters, both the drill and the checkerboard types. Figure 631 shows a fertilizer attachment for tractor cotton-corn-drill planter.

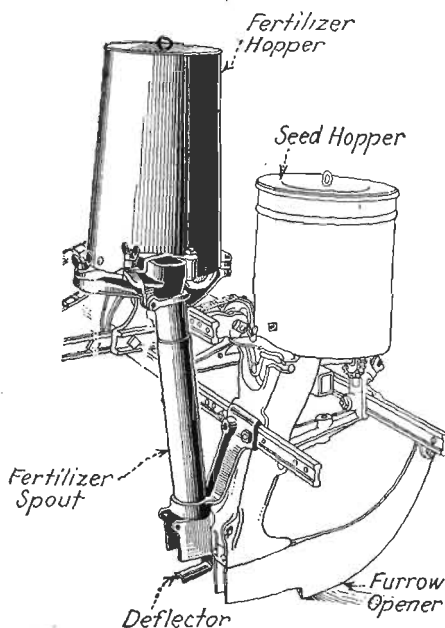


FIG. 630.—Fertilizer attachment with deflector to scatter the fertilizer, reducing contact between seed and fertilizer.

668. For Bean and Beet Planters.—A fertilizer attachment for bean and beet planter is shown in Fig. 632.

669. For Potato Planters.—Fertilizer attachments for potatoes should be adjustable so that the amount of fertilizer applied per acre may be varied from 200 to 1,000 pounds. Since potato sprouts are very sensitive

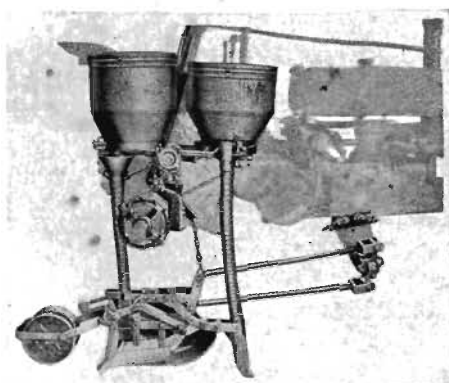


FIG. 631.—Fertilizer attachment for tractor planter.

to fertilizer salts, it is essential that the fertilizer be placed along the sides of the seed at about the same level as shown in Fig. 633.

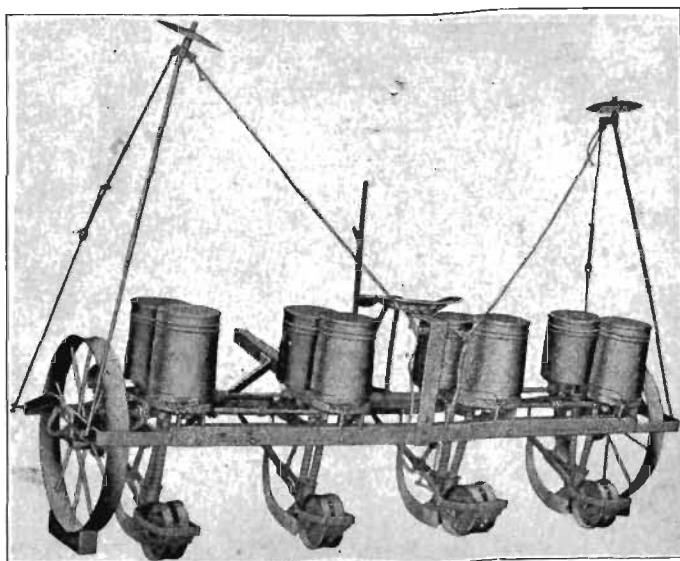


FIG. 632.—Beet and bean planter with fertilizer attachment. The fertilizer is distributed in direct contact with the seed.

670. Grain-drill Fertilizer Attachments.—Fertilizer attachments for grain drills consist of a specially constructed hopper having a partition extending lengthwise through the middle (Fig. 634). The planting unit is in the front half of the box, while the fertilizer unit is in the rear half.

Many fertilizer drills release both seed and fertilizer through the same tube. This is not good practice because the seed are in direct contact with the fertilizer (*A*, Fig. 635). A better method would be to release the fertilizer through separate tubes which will place the fertilizer in the



FIG. 633.—Steps in distributing fertilizer when planting potatoes: 1. Opening furrow for fertilizer; 2, depositing the fertilizer; 3, opening furrow and dropping potato set; 4 covering potato and fertilizer.

drills above the seed, as shown in *B*, Fig. 635. Figure 297 shows an attachment by which the fertilizer is placed above the seed.

671. Cultivator Attachments.—A fertilizer attachment for cultivators to apply a side dressing of fertilizer after the plants are well advanced is shown in Fig. 636. The hopper for the fertilizer is mounted above the

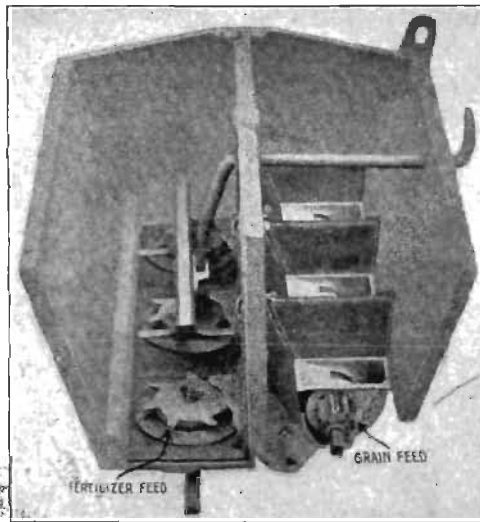


FIG. 634.—Cross-section of hopper showing grain and fertilizer feeds.

wheel—one for each side. The distributing mechanism is driven from the wheel by a sprocket attached to the spokes.

The fertilizer is released through a tube, the lower end of which deposits the fertilizer in the furrow behind one of the shovels, as shown in Fig. 637.

BROADCAST LIME AND FERTILIZER SOWERS

Figure 638 shows a machine suitable for broadcasting either lime or fertilizer. Usually, a wire screen is used in the top of the hopper to remove large lumps and prevent clogging of the feeds.

The feeds drop the lime or fertilizer

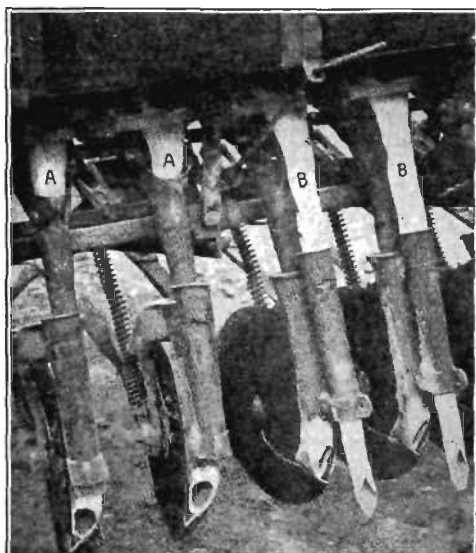


FIG. 635.—Combination grain and fertilizer drill: *A*, fertilizer being released in the same tube in contact with the seed; *B*, separate fertilizer tubes which place fertilizer in the soil above the seed.

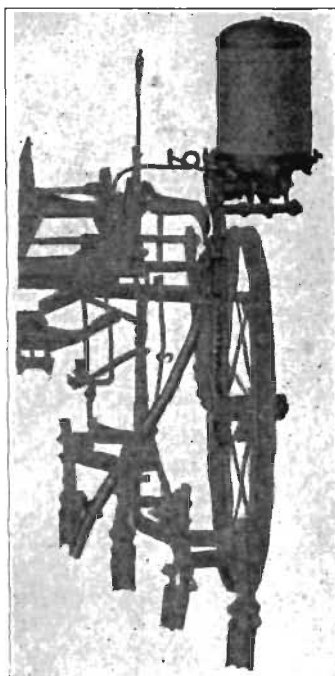


FIG. 636.—Fertilizer attachment for cultivator to apply side dressing to one or both sides of plants while cultivating.

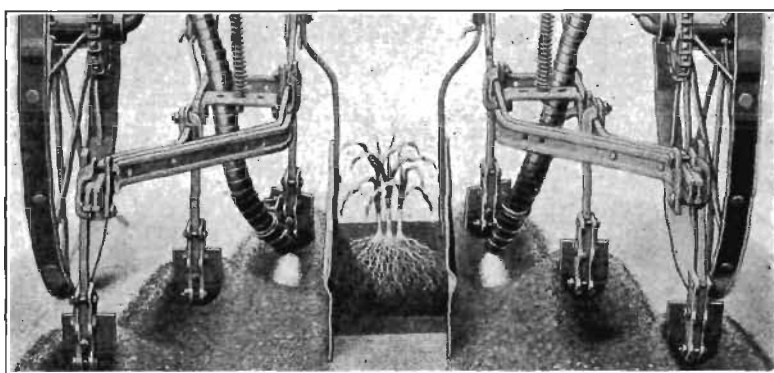


FIG. 637.—Fertilizer being placed in the soil behind the shovel by a cultivator-fertilizer attachment.

on a scattering board which deflects and scatters the material so that it will be more thoroughly broadcasted.

An inexpensive end-gate lime spreader is shown in Fig. 639. It is similar in construction to that of the end-gate seeder with the exception

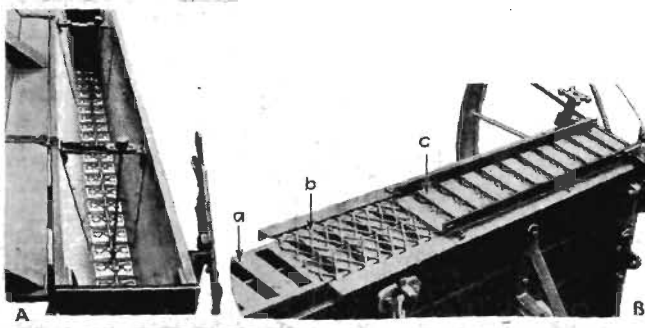


FIG. 638.—Two views of agitator or reciprocating broadcast fertilizer feed: *A*, looking into box; *B*, box inverted with feed plates and lower bottom cut away. *a*, upper bottom, *b*, perforated feed plate, *c*, lower bottom with outlets.

that the hopper is flush with the wagon box and the revolving scattering disks are much closer to the ground.

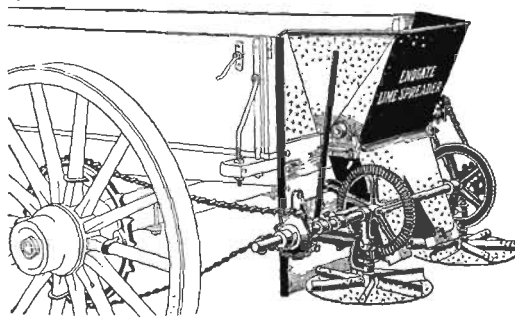


FIG. 639.—End-gate lime sower or spreader.

FERTILIZER FEEDS

The efficiency of any fertilizer-distributing machine depends upon the proper handling of the fertilizer by the feeding mechanism. There are a number of factors that will influence the efficiency of the feed and some are:

1. Climatic conditions, based on temperature and rainfall.
2. Amount of fertilizer to be applied.
3. Kind of fertilizer:
 - a*. Chemical composition.
 - b*. Physical state.

Many attempts have been made to design a fertilizer feed that will handle any and all kinds of fertilizer, distributing any desired quantity.

As a result, several different types are being used. These may be classified as:

1. Finger feed.
2. Disk feed.
3. Screw-conveyor feed.
4. Revolving-bottom feed.
5. Vibrator feed.
6. Rotary feed.
7. Winged-wheel feed.

672. Finger Feed.—The finger feed is also known as the *star* or *wizard* feed. It is the most generally used type of fertilizer feed. Figures 640

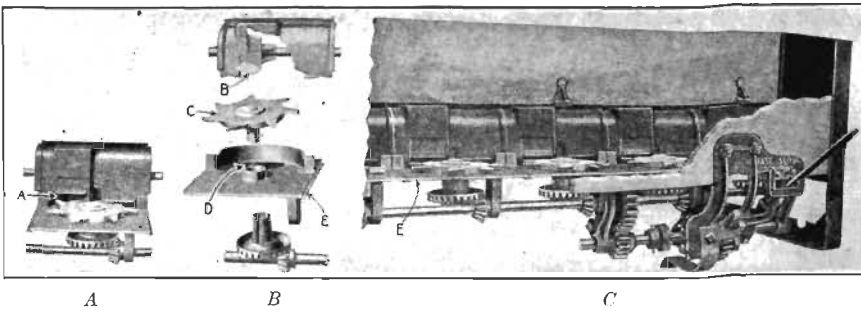


FIG. 640.—Fertilizer feed taken apart in B; assembled in A; and a section of the hopper with the feeds installed in C. A and B, adjustable gate; C, revolving disk; D, opening in hopper bottom for fertilizer to drop through; E, hopper bottom.

to 642 show the various installations, adjustments, parts, and methods of drive.

The feed consists of a finger plate in the bottom of the box. The fertilizer is caught by the fingers on the plate and carried through the gate opening to the back of the box where it is dropped into the spout. This type of distributor is used in many different types of attachments, but is more often used in the fertilizer drills.

The quantity of fertilizer distributed per acre is varied by changing the speed of the plate and by regulating the gate opening. The speed of the plate is controlled in a manner almost identical with that of the internal double-run grain feed, as shown in Fig. 642.

673. Marks or Cone Feed.—This consists of an inverted cone which has a projecting lip, the whole of which is stationary (Fig. 643). Beneath this lip there is a revolving plate that brings the fertilizer to the lip which gathers up a certain amount and carries it to the center of the cone and drops it through the spout into the soil. The quantity per acre is controlled by varying the speed of the plate beneath the cone. Different size cones can be secured for distributing different types of fertilizers and are known as the *standard*, *half-standard*, *double-standard*,

and *hen manure*. The one big objection to this type of feeder is that damp fertilizer will stick to the inside and fail to drop out through the spout.

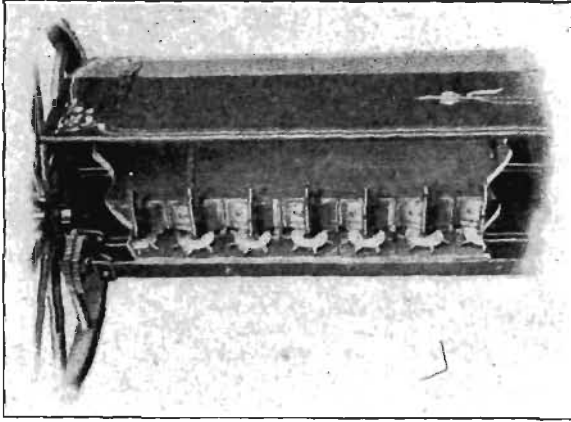


FIG. 641.—Finger feed with vertical agitators.

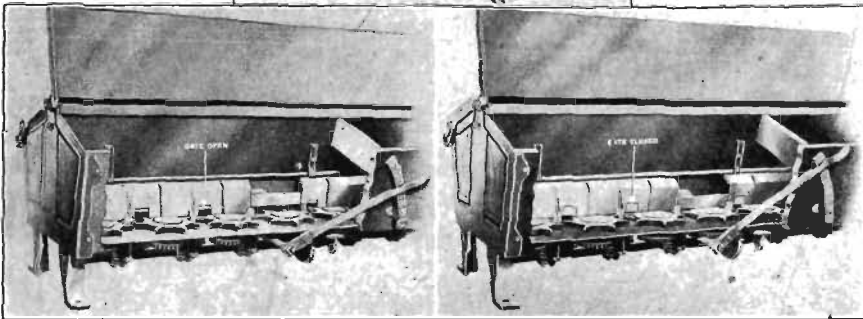
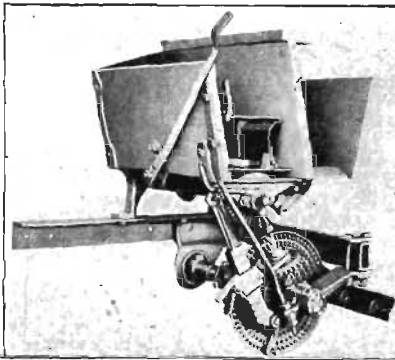


FIG. 642.—Fertilizer feed showing gate closed and open, and driving mechanism.

674. Winged-wheel Feed.—Figure 644 shows a fertilizer sower that is equipped with winged wheels to distribute the fertilizer. The fertilizer

is carried by a shaker box to the feeds which drop it on the distributing wheels.

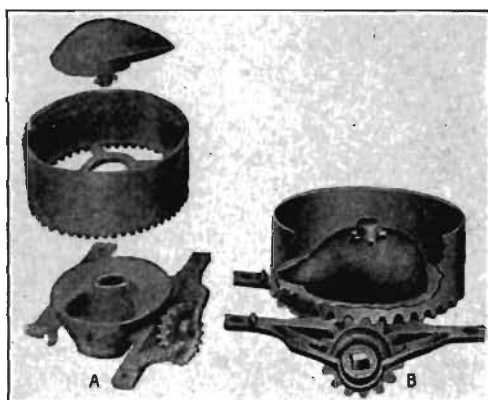


FIG. 643.—The marks or cone fertilizer feed: *A*, various parts of the feed; *B*, the feed assembled.

675. Screw-conveyor Feed.—This type of feed is shown in Fig. 645. A screw conveyor is placed in the bottom of the hopper to convey the fertilizer out. Above the conveyor is an agitator to keep the fertilizer from bridging.

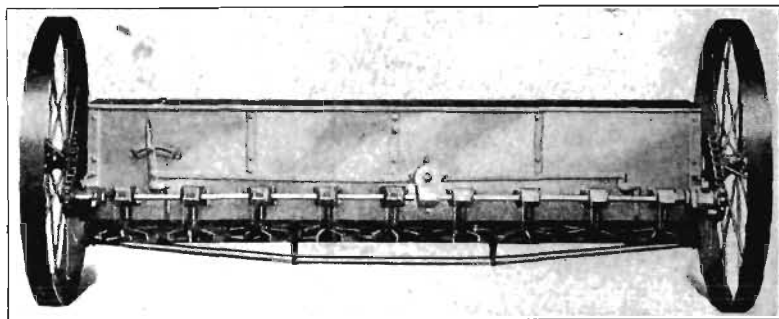


FIG. 644.—Winged wheels to distribute fertilizer.

676. Revolving-bottom Feed.—The revolving-bottom fertilizer feed, as shown in Fig. 646, is used rather extensively on attachments for planters and cultivators. The fertilizer in the hopper rests on a rotating bottom; as the bottom revolves, the contents are constantly agitated to keep them from bridging. As the bottom revolves, the outer portion of the fertilizer is carried against a stationary feed plow or inclined plane which scoops out a quantity and ejects it into the fertilizer tube.

The amount of fertilizer is regulated by raising or lowering the hopper. Raising increases the feed, while lowering decreases the feed.

677. Vibrator or Knocker Feed.—The vibrator feed is used on both the machines that apply fertilizer as a separate operation and those that apply it at the same time seed are sown.

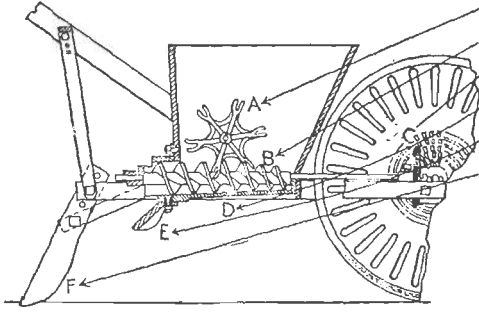


FIG. 645.—Screw-conveyor fertilizer feed.

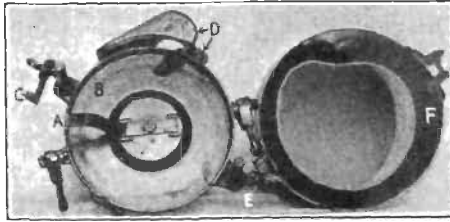


FIG. 646.—Working parts of fertilizer attachment shown in Fig. 627; *A*, shows the revolving bottom *B* with agitator attached. The stationary plow *D* deflects a quantity of the fertilizer over the side into the spout; *C*, control cranks; *F*, hopper which fits on the hopper bottom.

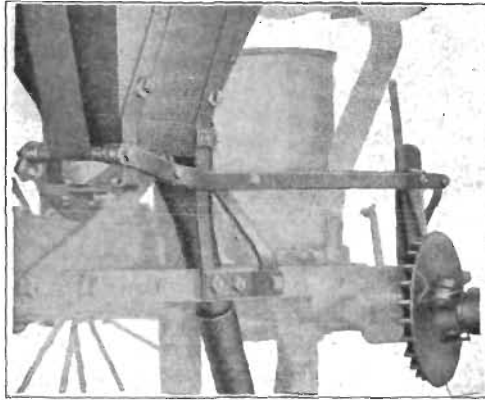


FIG. 647.—Vibrator or knocker distributor mounted on a one-row riding cotton and corn planter.

Figure 647 shows the vibrator feed arrangement mounted on a one-row riding planter. The vibrator arm is operated by a detachable gear on the main axle. An adjustable gate in the bottom of the hopper allows more or less fertilizer to be shaken out depending on the setting.

678. Rotary-winged Feed.—For lime and fertilizer sowers special rotary-winged feeds are used, as shown in Fig. 648. The feed shafts are

in two parts and can be lifted out to facilitate cleaning of the hopper. One-half of the feed is driven by each wheel.

679. Top-delivery Feed.—The top-delivery feed (Fig. 649) will distribute accurate amounts of fertilizer in a continuous uniform band.

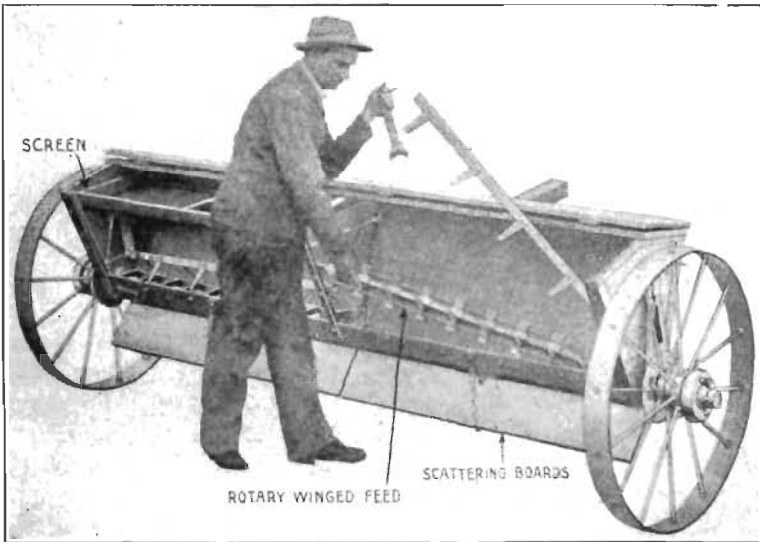


FIG. 648.—The rotary-winged fertilizer feed is easily removed.

The hopper revolves and turns a screw, which raises the hopper bottom so that from one to four stationary adjustable-delivery blades in the hopper head scrape off a uniform amount of fertilizer into the tubes.

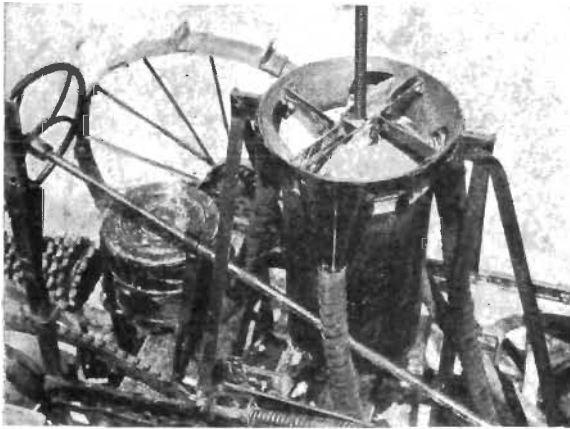


FIG. 649.—Top-delivery fertilizer feed. (U. S. Dept. Agr. Bur. Agr. Eng.)

By changing the size of either gears or sprockets, the speed at which the hopper revolves can be changed, thus changing the rate of fertilizer application.

PART XII

TRANSPORTATION EQUIPMENT

CHAPTER XXXIV

WAGONS, MOTOR TRUCKS, AND TRAILERS

Among the various changes taking place in farm equipment and agricultural practices is the method of transporting farm commodities. Three general types of vehicles are used to transport farm products and supplies on the farm and to and from market; namely, the wagon, the motor truck, and the automobile or truck trailer. The use of the farm wagon is now confined almost entirely to the farmstead, but the motor truck and automobile trailer are used not only on the farm but for transporting commodities to and from market. The fast motor vehicles are rapidly replacing the slow horse-drawn wagons.

THE FARM WAGON

There are two classes of wagons: the farm truck and the farm wagon.

680. The Farm Truck.—The farm truck consists of front and rear gears¹ and four low steel wheels of the same diameter (Fig. 650).

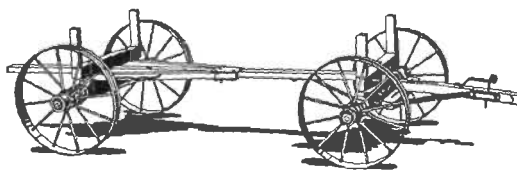


FIG. 650.—Farm truck.

681. The Farm Wagon.—The farm wagon is made in sizes suitable for use with one horse or a team of two or more horses. Where only one horse or mule is available for power, the one-horse wagon is used, but where a farm requires a team of two or more horses or mules, the two-horse wagon prevails (Fig. 652). Heavy wagons for four, six, and eight horses can be obtained. There is usually a difference of about four inches in the diameters of the rear and front wheels.

682. Selecting a Wagon.—In selecting a wagon the following points should be considered: the height or diameter of the wheels, the width of

¹ The wagon without the box is termed the running gear.

tire, strength and capacity, and the kind of box. Detail points of construction that are important are: materials of construction, especially the felloe;¹ dish of the wheels; thickness and width of tires; construction of gears, type of tongue (whether stiff or drop type); kind of axles, kind of bearings, size and type of box. Wagon wheels should have *front* and

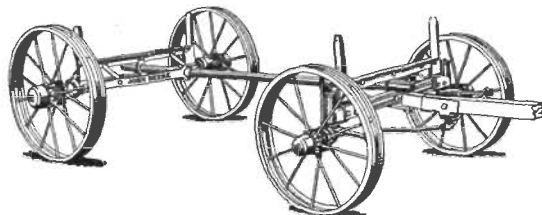


FIG. 651.—Steel-gear farm truck.

bottom gather. In an automobile these are called *toe-in* and *camber*. In either case they serve the same purpose.

683. Draft of Wagons. —The draft of wagons is influenced by three principal factors; namely, axle friction, rolling resistance, and grade resistance.

Axle friction is the resistance caused by the wheel box or bearing turning about the axle or skein. *Rolling resistance* is influenced by the

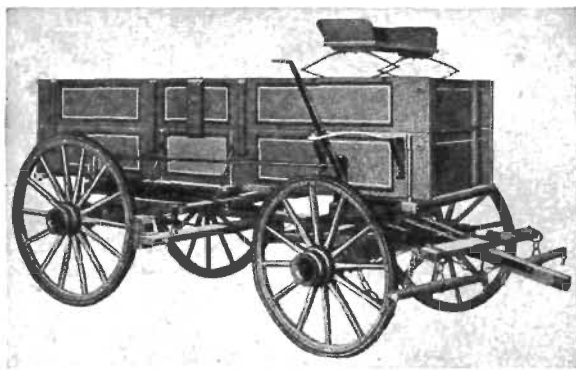


FIG. 652. Two-horse farm wagon, equipped with seat and brake supplied as extra equipment.

height of the wheels, the width of tires, and the nature of the surface supporting the wheel. When a wheel sinks in a surface, the effect is practically the same as rolling up an incline. Tables XXIV and XXV show the influence of the height of wheels and width of wheels.

Tests to determine the influence of the width of tire on the draft were also conducted by Wooley and Jones. The results are shown in Table XXV.

¹ The felloe is the wood rim around the spoke ends over which the iron tire is fitted.

TABLE XXIV.—DRAFT OF WAGON WITH WHEELS OF DIFFERENT HEIGHT AND ON DIFFERENT KINDS OF ROADWAY¹

Kind of roadway	Height of wheels		
	Low	Medium	High
Worn brick pavement.....	115.8	98.0	97.0
New brick pavement.....	89.5	73.5	70.7
Concrete pavement.....	93.7	87.5	82.0
Macadam.....	112.4	.....	105.0
Dirt road, dry.....	388.5	347.9	333.8
Dirt road, muddy.....	441.1	367.8	342.3
Cinder roadway, dry.....	164.4	.....	128.9

¹ *Ann. Rept. Mo. Agr. Expt. Sta. Bull. 210, 1922-1923.*TABLE XXV.—DRAFT OF WAGON WITH TIRES OF DIFFERENT WIDTH AND ON DIFFERENT KINDS OF ROADWAY¹

Kind of roadway	Width of tires	
	Narrow, 1½ inches	Wide, 4 inches
Worn brick pavement.....	99.9	81.6
New brick pavement.....	82.4	75.4
Concrete pavement.....	93.0	83.8
Dirt road, dry.....	357.4	310.0
Dirt road, muddy.....	360.6	363.0

¹ *Ann. Rept. Mo. Agr. Expt. Sta. Bull. 210, p. 33, 1922-1923.*

Grade resistance depends upon the grade of the road or the rise in feet per 100 feet. The following table gives the draft per ton of load for a wagon on a level road and for various percentages of grades on different road surfaces.

TABLE XXVI.—INFLUENCE OF GRADE ON DRAFT OF WAGONS

Grade, percentage	Macadam, pounds	Gravel, pounds	Sand or earth, pounds
Level.....	50	140	240
1	70	160	260
2	90	180	280
5	150	240	340
10	250	340	340
15	350	440	540

MOTOR TRUCKS

The motor truck is becoming as essential to the farmer as it is to the merchant. The type of hauling required by the truck varies with the type

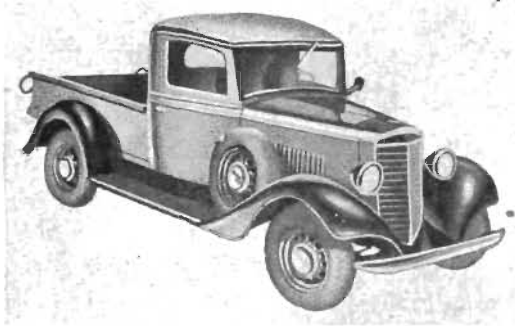


FIG. 653.—Half-ton light delivery pickup truck.

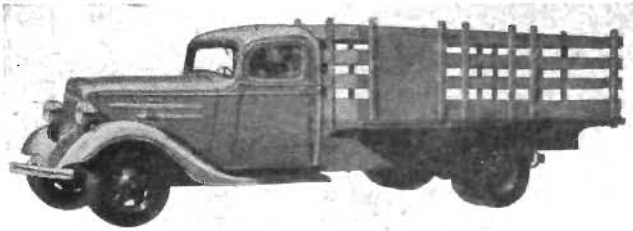


FIG. 654.—One-and-one-half-ton truck equipped with general-purpose stake body.

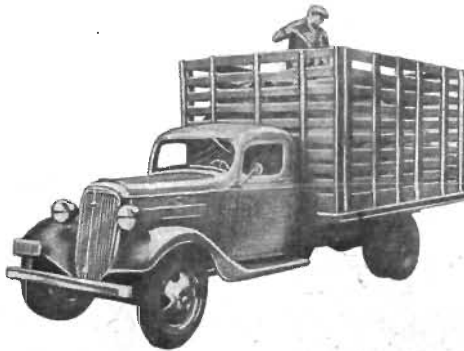


FIG. 655.—One-and-one-half-ton truck equipped with high rack body suitable for livestock.

of farming, which may be dairy, poultry, general livestock, grain, fruit, vegetable gardening, or cotton farming. Consequently, the type and size of truck will vary according to the needs of the particular type of farm. The sizes of motor trucks are rated according to capacity and range from $\frac{1}{2}$ ton to 2 tons. The popular sizes are the $\frac{1}{2}$ -, 1-, and $1\frac{1}{2}$ -ton

sizes. Figure 653 shows a $\frac{1}{2}$ -ton light-delivery pickup truck, and Fig. 654 shows a $1\frac{1}{2}$ -ton stake-body truck. Tight box bodies for hauling grain are available.

684. Cost of Operating Trucks.—The cost of operating a truck will vary with the size, type of hauling, road conditions, size of load, topography, and other factors.

Church¹ found in his study of motor truck operation that the cost per mile varied from 7.8 cents for the $\frac{1}{2}$ -ton size for hauling crops to 20.7 cents for the 2-ton size. The cost per ton-mile for hauling crops ranged from 37.3 cents for the smaller trucks to 15.8 cents for the larger size.

TRAILERS

There is a decided trend in farm transportation to use trailers behind both trucks and automobiles. When a small trailer is hitched behind an automobile, farm products and supplies can be transported to and from market at little extra expense. A trailer also saves the family car from much abuse and the occupants are able to ride in comfort. A trailer will add much to the capacity of a truck, especially the small light-delivery pickup type.

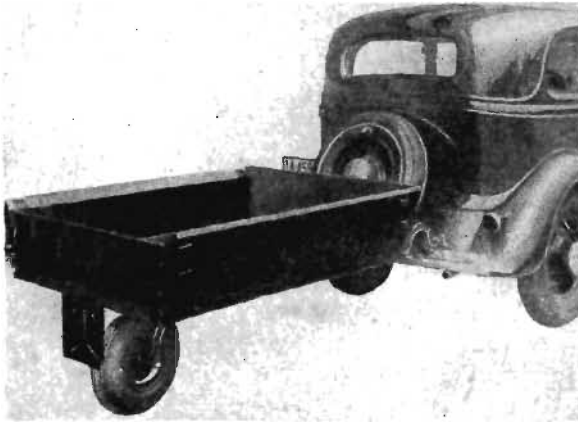


FIG. 656.—A one-wheel trailerette.

685. Types of Trailers.—Trailers may be classed according to their wheel equipment as the one-wheel, two-wheel, and four-wheel types. There are, of course, the two-wheel heavy-duty industrial trailers equipped with dual tires.

686. The One-wheel Trailer.—Figure 656 shows a light one-wheel "trailerette," which provides a convenient means of transporting small light articles. Open or closed wheels can be supplied. Brackets on each

¹ U. S. Dept. Agr. Bull. 1254, p. 23, 1924.

of the two front corners attach to the bumper of the car, thus giving horizontal rigidity but vertical flexibility for uneven surfaces. The

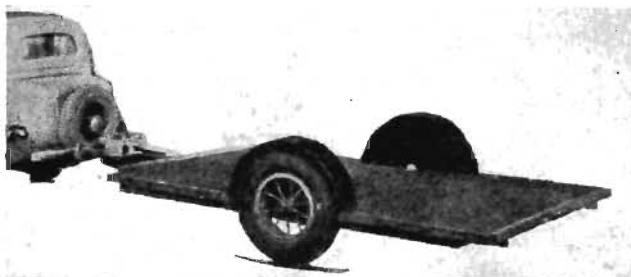


FIG. 657.—Low-platform two-wheel trailer.



FIG. 658.—Two-wheel general-utility trailer. Note the folding legs to support front of trailer when not hitched to car.



FIG. 659.—Two-wheel trailer transporting a horse.

single wheel under the trailer castors permits the car and trailer to be parked, backed, and turned without attention to the trailer.

687. The Two-wheel Trailer.—Two-wheel trailers suitable for farm use are shown in Figs. 657, 658, and 659. The local blacksmith makes

small trailers of this type out of discarded automobile chassis at a low cost. They can, however, be purchased from commercial concerns at

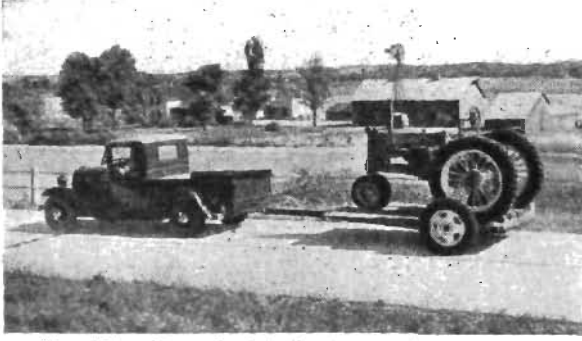


FIG. 660.—Two-wheel trailer transporting a tractor.

prices as low as \$65.00. The trailer shown in Fig. 659 is equipped with high sides for transporting horses, cattle, and other livestock. A low

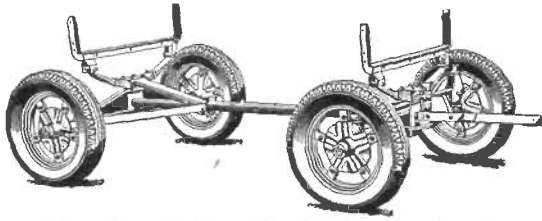


FIG. 661.—Four-wheel combination farm truck and trailer.

platform trailer is shown in Fig. 660 hauling a tractor behind a light $\frac{1}{2}$ -ton pickup truck.

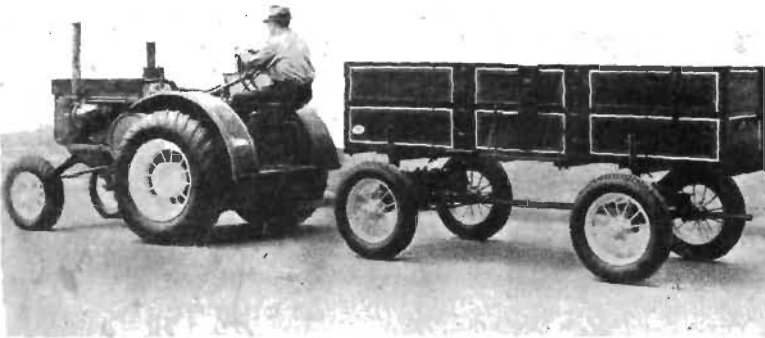


FIG. 662.—Four-wheel trailer hitched to a tractor.

When the two-wheel trailer is properly hitched, there is no tendency for it to whip, and moderately rapid speeds can be made with this type.

688. The Four-wheel Trailer.—Figure 661 shows a commercially built four-wheel trailer, which can be used with an automobile, truck, or tractor (Fig. 662), and with teams by substituting a pole for the trailer hitch. The wheels are equipped with roller bearings, demountable rims, and pressure fittings for good lubrication. A rigid construction prevents whipping.

689. Two-wheel Trailer Hitches.—Numerous methods have been used for hitching trailers, and some of them are good, but some are poor makeshifts and dangerous for high speeds and rough conditions.

The ball-and-socket connection shown in Fig. 663 is considered an excellent hitch. It is easily attached and detached. The sleeve just

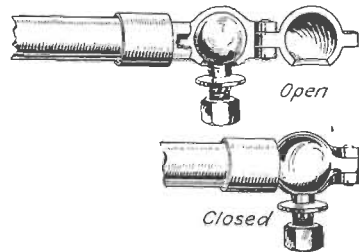


FIG. 663.—Ball-and-socket trailer hitch.

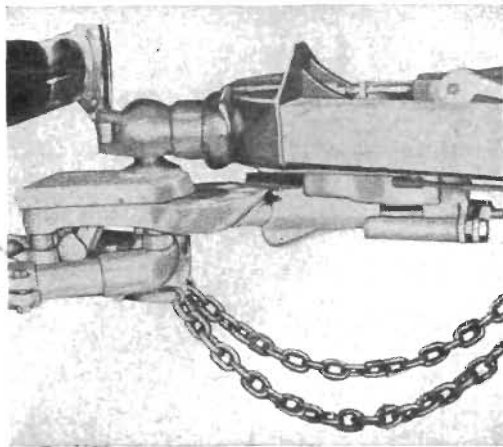


FIG. 664.—Trailer hitch equipped with automatic brake.

back of the ball is under spring pressure and can be drawn back to permit one side of the socket to swing out on a hinge, releasing the socket from the ball. The ball-and-socket connection gives flexibility in all directions,



FIG. 665.—Showing construction and application of hitch for four-wheel trailer.

but at the same time it maintains rigidity and prevents whipping of the trailer. The hitch shown in Fig. 664 is equipped with an automatic

braking device. When brakes are applied on the car the trailer pushes forward on the hitch and automatically applies the brakes on the trailer without attention from the driver.

690. Four-wheel Trailer Hitches.—A hitch similar to the one shown in Fig. 665 can be obtained suitable for hitching almost any automobile

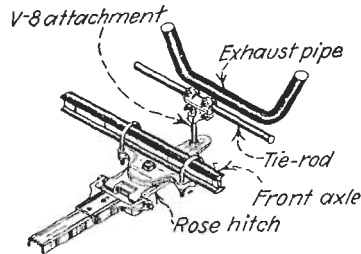


FIG. 666.—Details of four-wheel trailer hitch for 1935 Ford V-8.

chassis behind another car or truck. Figure 666 shows a connection for a 1935 Ford V-8 automobile. To prevent whipping the tie rod must be held rigid and there should not be looseness in the other connections of the steering mechanism. The front wheels must be properly adjusted for toe-in and camber.

PART XIII

CLEANING AND GRADING MACHINERY

CHAPTER XXXV

CLEANERS AND GRADERS

The importance of cleaning grain before marketing and the cleaning and grading of seed before planting is being recognized by grain growers more and more every year. The selection of good seed is a very essential step in the production of any crop. Certified seed breeders practice cleaning and grading of the seed they plant and sell.

Black¹ states that in 1923 the average wheat dockage of North Dakota was 11.3 per cent, and over 15 per cent of the flax crop was dockage; that Dakota produced over 9,000 carloads of dockage that year.

The Federal Grain Standards define dockage for wheat as sand, weed seeds, weed stems, chaff, straw, grain other than wheat, and any other foreign material which can be removed readily from the wheat by use of appropriate sieves, cleaning devices, or other practical means suited to separate the foreign material present.

691. Type of Cleaners.—There are several types of grain-cleaning machines. Some types are suited for use in elevators or large granaries; other types are adaptable for farm use.

In general, grain cleaners and grain graders clean and grade the seeds according to:

1. The size of the seeds.
2. The shape of the seeds.
3. The specific gravity of the seeds.
4. The combinations of either size, shape, or weight of the seeds.

The actual separation is accomplished by means of sieves and air, by cylinders, and by pockets in the side of disks or belts. The cleaners using sieves and air methods of separation are termed *fanning mills*.

692. Fanning Mills.—Fanning mills are made in sizes suitable for use in elevators and on farms. Figure 667 shows a cross-sectional view of a mill used in elevators, while Fig. 668 shows a cross-section of a small farm fanning mill.

¹ *Agr. Eng.*, Vol. 6, No. 8, p. 180, 1925.

The grain to be cleaned is poured into a hopper on top of the mill from which it is fed on to the sieves or screens. These sieves are shaken either sidewise or endwise. In the side-shake mill, the movement of the sieves is at right angles to the flow of grain, while in the end-shake type, the movement is parallel to the flow of the grain.

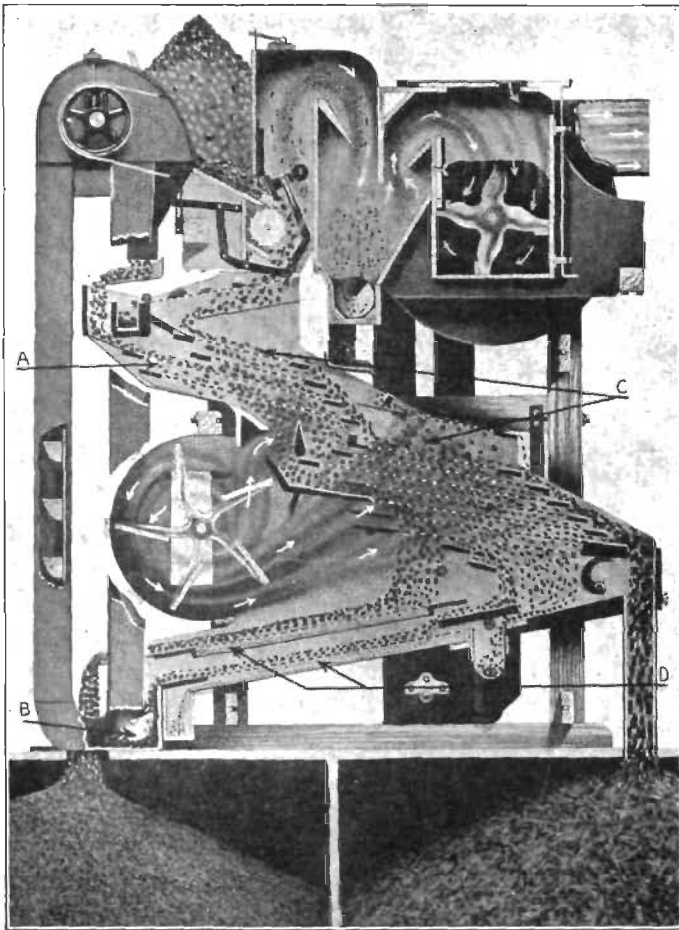


FIG. 667.—Cross-section of elevator-type fanning mill using air and sieves. Air suction removes dust and chaff as the grain is fed into the machine while the sieves separate the dockage from the wheat.

The number of sieves used and the angle at which they are set vary in the different makes of fanning mills. It is always best to follow the operating directions furnished by the manufacturer. Different types of perforated sieves and screens can be placed in the machine to clean and grade different kinds of seeds.

The fan should furnish a blast of air of sufficient volume and velocity to remove dust, pieces of straw, and light, immature, and diseased seeds. The blast can be regulated by the wind boards on each end of the fan-case housing.

In fanning mills the blast may operate through, above, under, parallel to, or at right angles to the sieve and grain.

693. Oat Kickers.—The machine shown in Fig. 669 is commonly called an *oat kicker*. It differs from the fanning mill in that the sieves are placed at a great angle and are similar in construction to the chaffer of a thresher. The wheat kernels pass through the angle in the throat

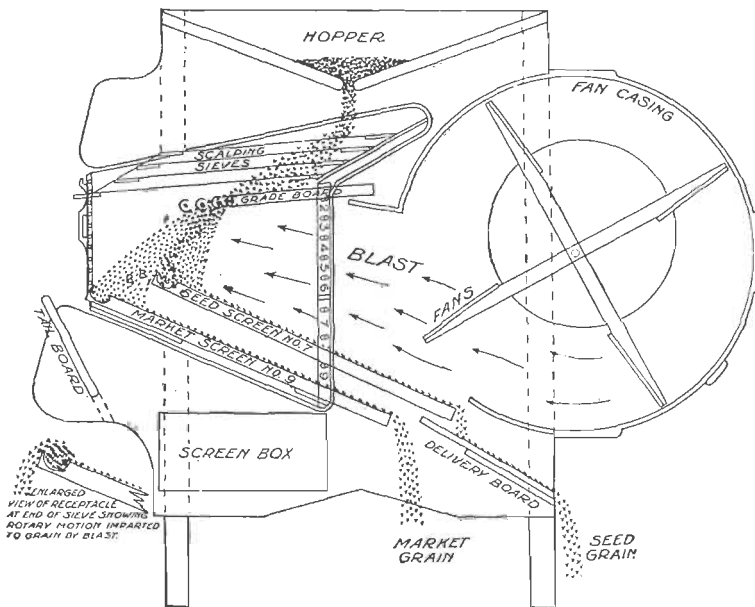


FIG. 668.—Cross-section of a farm fanning mill.

of the sieve, while the oats, being too long to pass through this angle, are kicked backward in the direction of the throw of the sieve or riddle and are finally discharged from the machine. The wheat kernels and fine seeds fall through the sieves on a screen below, where the fine seeds are screened from the wheat.

694. Disk Cleaner and Grader.—The disk type of cleaner, as shown in Fig. 671, is also called a *pocket cleaner*, because there are sieves of pocketed vertical disks used as the separating mechanism. In cleaning wheat, the weed seeds that are shorter than the wheat kernels fall into and remain in the pockets. Then, as the disk passes upward through the grain and the weed seeds the latter are carried out of the grain and discharged into a trough or hopper. Since the wheat kernels and wild oats are too

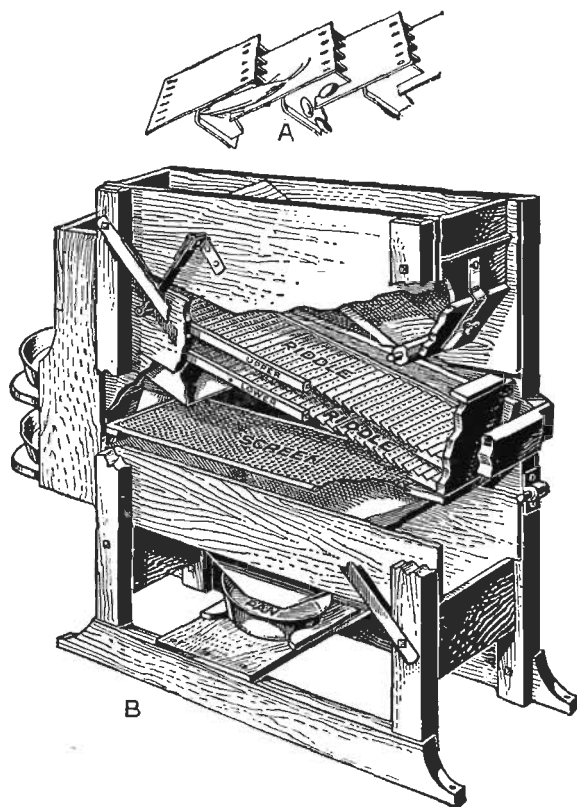


FIG. 669.—Wild oat kicker: *A*, section of sieve or riddle; *B*, cross-section of machine. (U. S. Dept. Agr. Bull. 1542.)

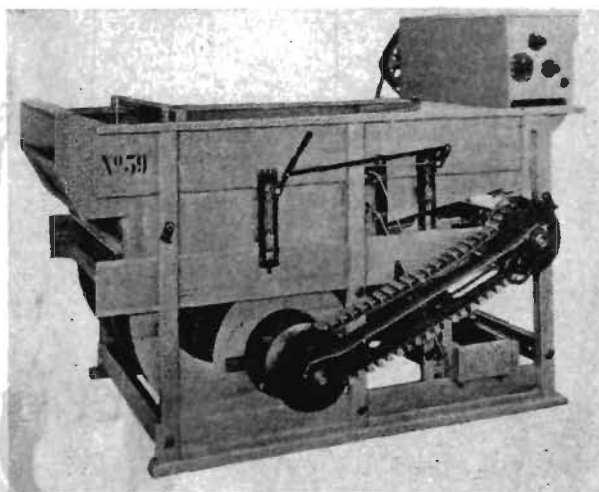


FIG. 670.—Fanning mill equipped with variable-speed pulleys by which the strength of the air blast and the number of vibrations per minute of the screens can be varied.

long to remain in the pockets, they are moved to another part of the machine in which the pockets are large enough to remove the wheat kernels from the wild oats (Fig. 671).

Disk cleaners are built in sizes suitable for use with threshing machines, on combines in farm granaries (Fig. 672), and small elevators.

695. Gravity Separator.—The spiral gravity separator (Fig. 673) utilizes both the difference in shape of the seeds and the difference in weight. As a stream of seed flows down the flat spiral incline, the

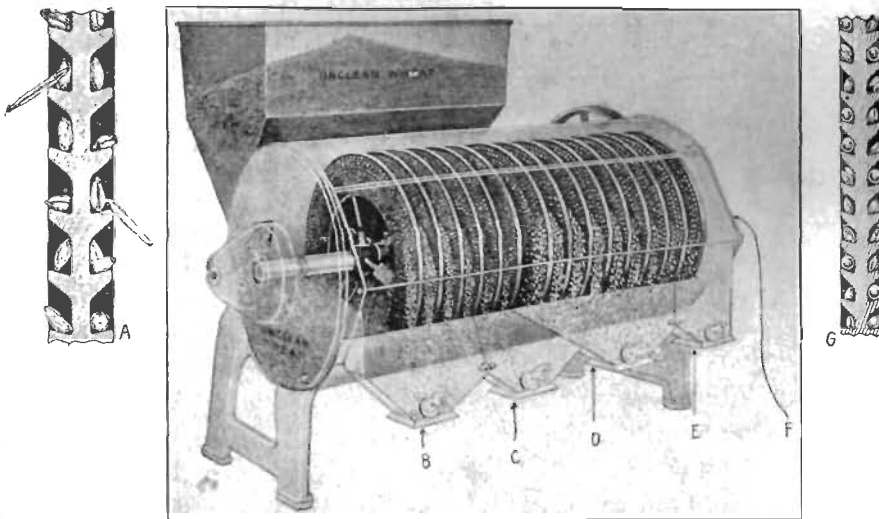


FIG. 671.—Sectional view of farm-size disk cleaner with cross-sections of the disks used.

heavier seed move faster and swing to the outside of the chute and are separated from the lighter seed.

CYLINDER CLEANERS AND GRADERS

696. For Wheat.—The cylinder cleaner and grader, as shown in Fig. 674, operates on the same general principle as that of the disk cleaner. Instead of pockets on the sides of disks, however, there are indented pockets on the inside circumference of the cylinder (Fig. 675).

The wheat and small seeds are caught in the pockets and carried upward out of the oats and dropped into a conveyor trough and conveyed separately out of the cylinder. Further separation of weed seeds and wheat is accomplished in another cylinder having pockets of suitable size (Fig. 675). The size and capacity of the machine are determined by the number of cylinders used.

697. For Corn.—A small inexpensive cylinder corn grader is shown in Fig. 676. It consists of a single or double cylinder with sections having

different size holes to allow different size kernels to pass through. One end of the cylinder is lower than the other which causes the kernels to move along inside the cylinder until they come to the section having the proper size outlet.

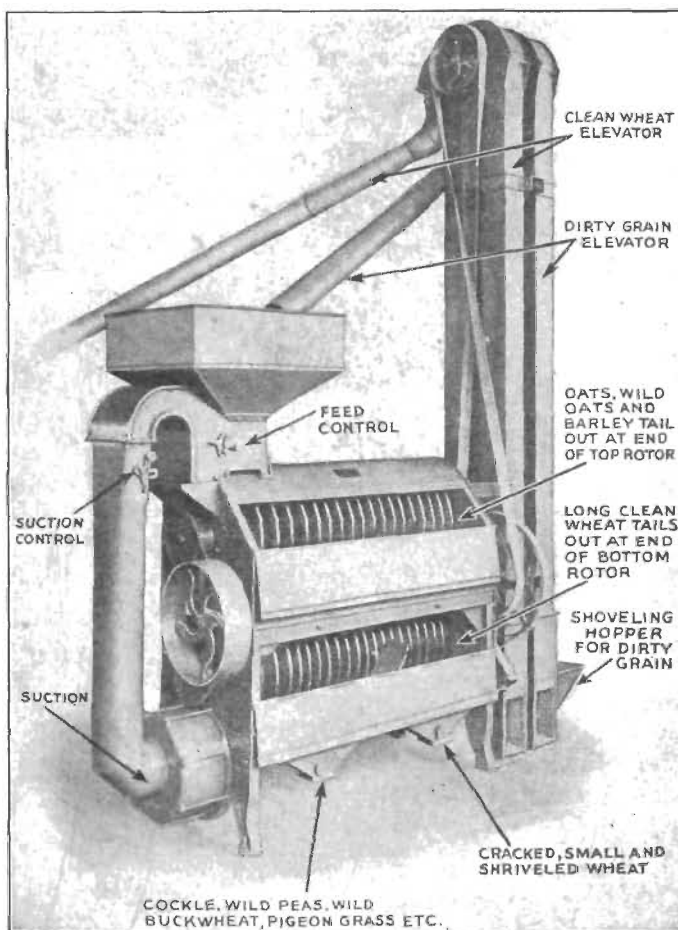


FIG. 672.—Double-disk cleaner suitable for small granaries.

698. For Cotton.—Cylinder graders are also used to grade cottonseed (Fig. 677). The cylinder is constructed, as in the case of the corn grader, with sections having different sized holes. In general, the action is similar to that of a sieve, but instead of a vibrating action there is a revolving movement to agitate the seed.

699. For Peanuts.—Figure 678 shows a cylinder constructed to grade peanuts.

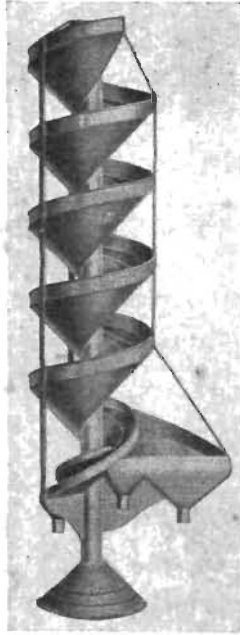


FIG. 673.—Spiral gravity separator.

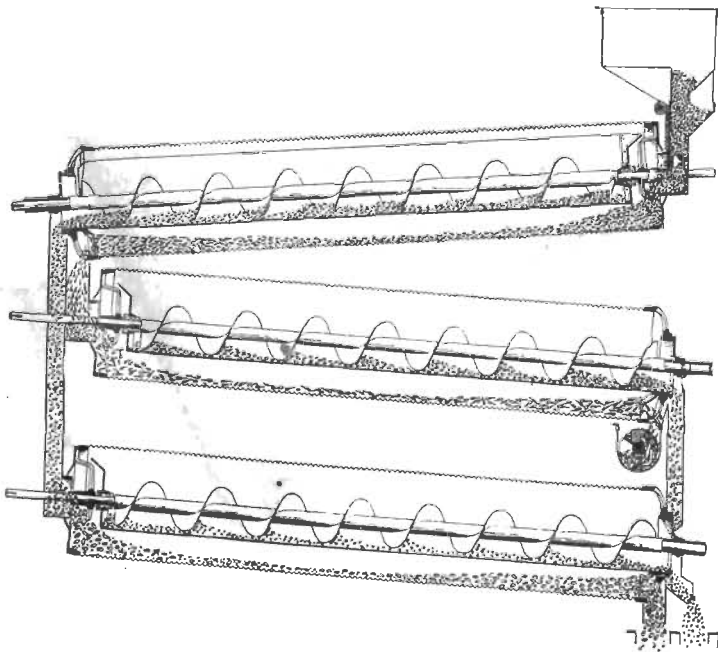


FIG. 674.—Longitudinal view of triple-cylinder cleaner.

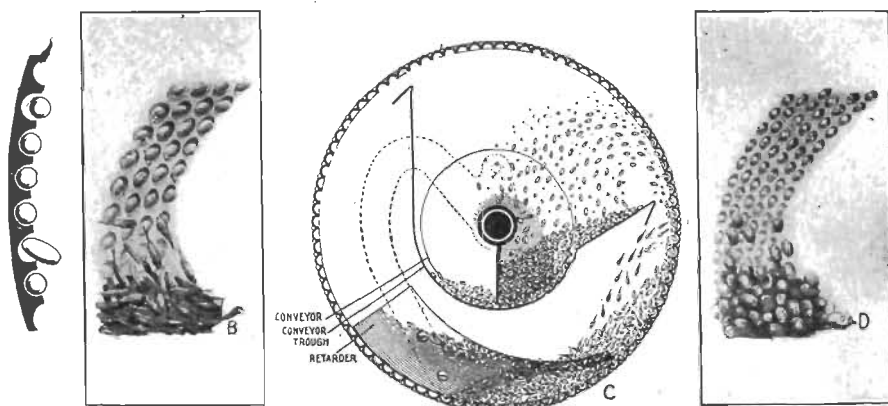


FIG. 675.—Cross-section of cylinder cleaner with enlarged sections showing the action of the pockets.

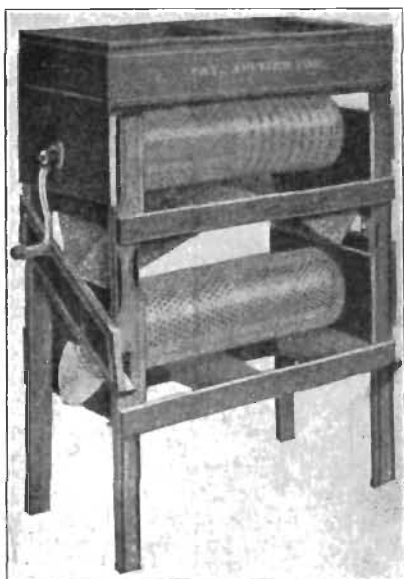


FIG. 676.—Double-cylinder corn grader.

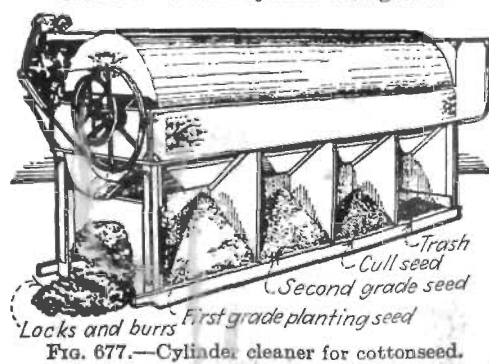


FIG. 677.—Cylinder cleaner for cottonseed.

700. Belt Separator.—The belt separator shown in Fig. 679 separates round from unround seeds by means of an endless up-travel belt, the pitch

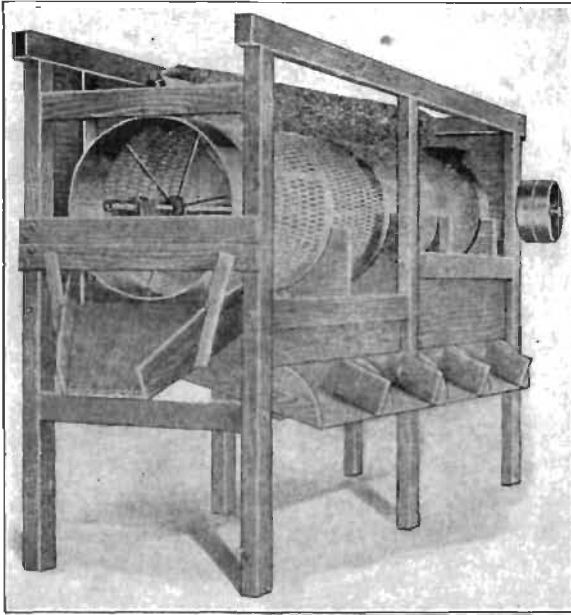


FIG. 678.—Peanut grader.

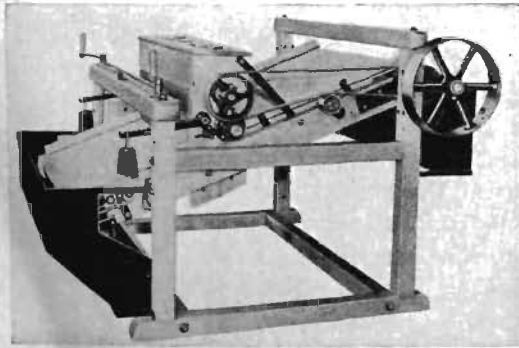


FIG. 679.—Belt cleaner to separate round from unround seed.

of which can be changed. As the belt travels upward, the round seed roll down and off the lower side, and the unround seed are carried up and over the upper side and discharged into a hopper.

PART XIV

SOIL- AND WATER-CONSERVATION MACHINERY

CHAPTER XXXVI

TERRACING MACHINERY

The world, especially the United States of America, is becoming conscious of the tremendous soil and water losses from agricultural lands. Of the many methods used to combat these losses, terracing is one of the fore-

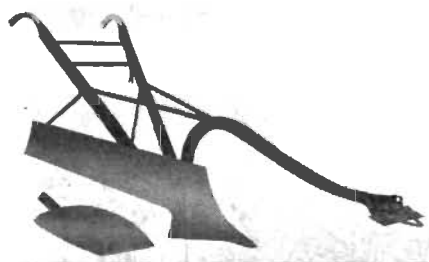


FIG. 680.—Terracing plow.

most. Consequently, machinery for building and maintaining terraces is becoming an essential farm tool. Terracing machines range in size from the small walking plow that may be drawn by one or two mules to the large road-building machine drawn by a 60-horsepower tractor. Between these extremes are the V-drags and ditchers, both

homemade and commercial types; ditcher-graders of many sizes; elevating graders; and a number of special machines. A successful terracing machine must be adaptable to work efficiently in all soil types, on gradual and steep slopes, on smooth or gullied land, in small and large fields, in cultivated fields and in pastures, in stumpy and rocky fields, and in dry and wet soils.¹

701. Plows.—A popular type of plow for the building of terraces is the walking moldboard plow equipped with a long grader blade-like moldboard (Fig. 680).

These plows are suitable for building low terraces on moderate slopes. The time and labor required to build terraces with such small equipment are excessive.²

Disk plows may be used to build terrace ridges, but they do not move soil so great a horizontal distance as do moldboard plows. They are also awkward to handle when used on a ridge.



FIG. 681.—Slip scraper.

¹ *Agr. Eng.*, Vol. 16, No. 1, pp. 3 and 5, 1935.

² *Agr. Eng.*, Vol. 16, No. 1, p. 3, 1935.

702. Slip Scrapers.—Slip scrapers (Fig. 681) are used in making fills where the terrace crosses gullies.

703. Fresno.—The fresno is not only used in making fills but also for building the terrace. Both horse-drawn (Fig. 682) and tractor-power dump types (Fig. 683) are used. One objection to the fresno is that the surface soil for a considerable distance on each side of the terrace is scraped off in building the terrace. Graders cut into and throw up much subsoil. A smooth terrace cannot be built with fresnos.

704. V-drags and Graders.—The wooden V-drag when properly constructed will move a good volume of loose soil several feet horizontally. A well-designed wooden V-drag is shown in Fig. 684. A grader-blade cutting-edge plate is attached to the wing. The landside and wing are covered with light galvanized sheet iron to provide better scouring surfaces.

Steel V-type terracers are equipped with a lever and front wheel assembly to raise and lower the front end (Fig. 685). An adjustable

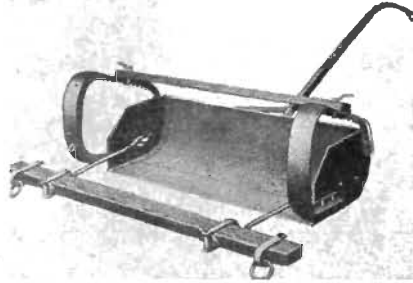


FIG. 682.—Horse-drawn fresno.

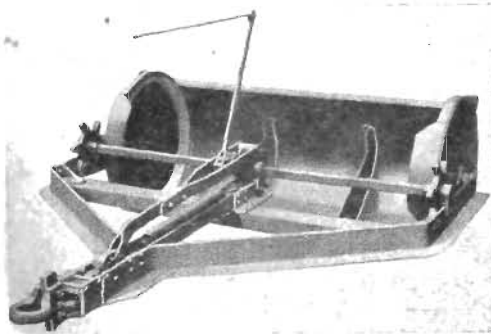


FIG. 683.—Tractor rotary fresno.

rolling coulter attached to the rear end of the landside gives lighter draft and holds the landside when a heavy load is carried on the blade. Extension bars push and smooth the soil beyond the end of the blade.

Construction costs with the steel V-type terracer are higher than when graders are used. Plowing to loosen the soil so the terracer can handle it is one factor that makes the cost high.

705. Three-wheel or Light-terracing Grader.—These terracers are pulled by teams or small farm tractors. When a small amount of power



(Courtesy W. H. McPheeters.)

FIG. 684.—Homemade wood V-drag. Note how the seat serves as a runner when turning. The small inset shows movement of soil by blade.

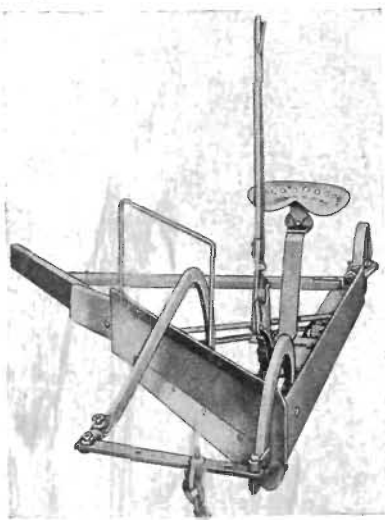


FIG. 685.—Steel V-drag.



FIG. 686.—Three-wheel light terracer grader.

is available on the farm, the terraces can be economically constructed with the small terrace graders.¹

This type of terracing machine is composed of a grader blade 6 to 8 feet long suspended under a beam (Figs. 686 and 687). Two coulter-like

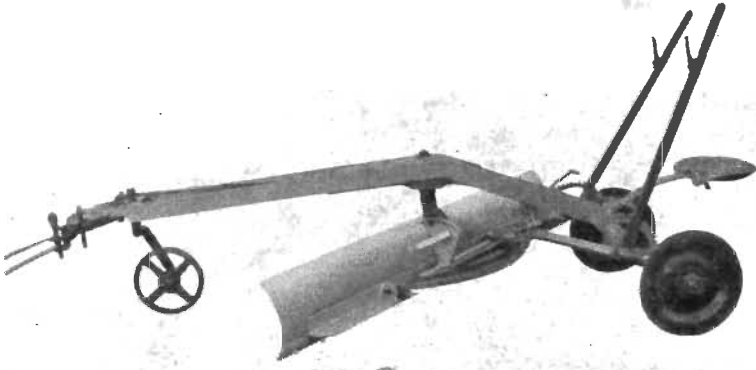


FIG. 687.—Side view of three-wheel terracer.

wheels are attached to the rear of the blade to provide a means of raising and lowering and in firm soil aids in overcoming side thrusts when loaded. A tongue truck supports the front end of the beam when horses supply the power, but it is removed when the machine is drawn by tractors. Provision is made for angling the blade, both to the right and to the left.

706. Two-wheel Terracer.—The two-wheel terracer is so called because the rear of the machine is supported and carried on two wheels

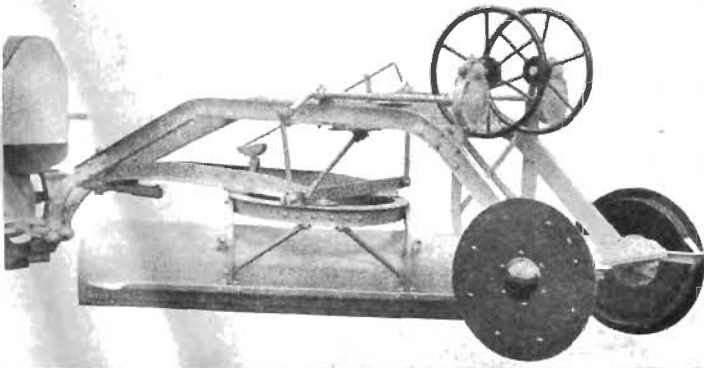


FIG. 688.—Two-wheel terracer.

(Fig. 688), and the front attaches directly to the tractor by some form of "gooseneck" hitch (Fig. 689). This arrangement permits short turns, makes it possible to work closer to the ends, and saves time in turning.

¹ *Agr. Eng.*, Vol. 16, No. 1, p. 3, 1935.

A tongue truck can be supplied if desired (Fig. 689). The heavy channel-iron box frame is welded together, giving rigidity and strength. The frame is arched over the blade and provides ample clearance. The blade

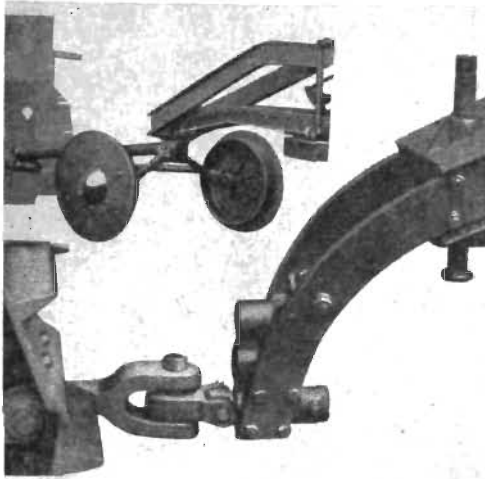


FIG. 689.—Tongue truck and gooseneck hitch for two-wheel terracer.

is raised and lowered by lifting cranks, operated by a hand-driven worm gear.

Two-wheel terracers are built in two sizes. The smaller weighs about 1,400 pounds and may be equipped with 8- or 9-foot blades. The larger machine weighs about 4,600 pounds and is equipped with a 10-foot blade. Simple devices are provided for changing the pitch, reversing and hori-



FIG. 690.—Two-wheel tractor terracer constructing a terrace.

zontal shifting of the blade. With a trained tractor driver the two-wheel terracer can be handled as accurately on a terrace ridge as the four-wheel grader.

Ordinarily, from six to ten round trips are required to construct a standard broad-base terrace with a 10-foot blade. The number of rounds required depend upon the condition of the land, type of soil, size of terrace, and whether the soil is loose or hard.

707. Four-wheel Terracers or Road Graders.—Large-sized road graders (Fig. 691) and the power required to pull them are too expensive

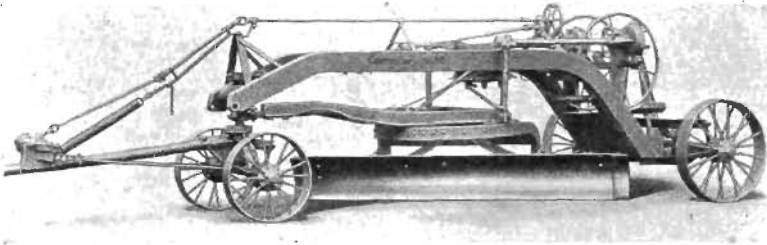


FIG. 691.—Four-wheel or road-grader terracer.

for the average farm. Unless several hundred acres are to be terraced, such an investment would not be justifiable. Most terracing with road machinery, therefore, is done with county or government owned equipment. A flat charge of from \$2.50 to \$3.50 per hour is the usual rate. In some sections farmers are cooperatively purchasing this type of equipment for terracing purposes. There are some sections where the charges made for use of such machinery are the actual operating expenses. On these terms costs range from \$1.37 to \$1.84 per hour.^{1,2}

Building terraces requires stronger and more durable machines than are required for road building. Efficient construction of terraces requires that the blade be loaded to capacity at all times. Pulling a heavily loaded machine over rough land and around sharp curves will test the durability of any machine. Well-built road-grading terracers weigh from 10,000 to 14,000 pounds and may be equipped with 10-, 12-, or 14-foot blades. On sandy loam soils these machines are capable of throwing up a terrace 18 to 24 inches in height and 24 to 26 feet in width in three to six round trips.

708. Elevating Graders.—The elevating grader is used to a limited extent where terraces are large. This machine requires a high initial

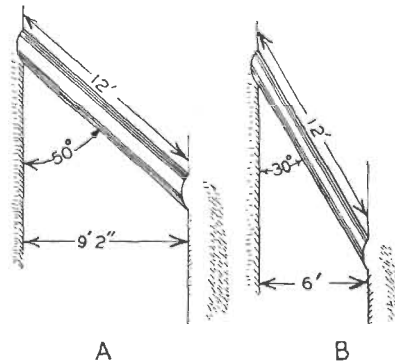


FIG. 692.—Cutting angles of grader blade: A, angle for moving loose soil; B, angle for deep cutting.

¹ *Agr. Eng.*, Vol. 16, No. 8, p. 315, 1935.

² *Proceedings of Fourth Southwest Soil and Water Conservation Conference*, 1933.

investment and is so complicated and requires so much power for operation that it is difficult to economically construct terraces with it. Generally where a 75-horsepower tractor and elevating grader are used a terrace core

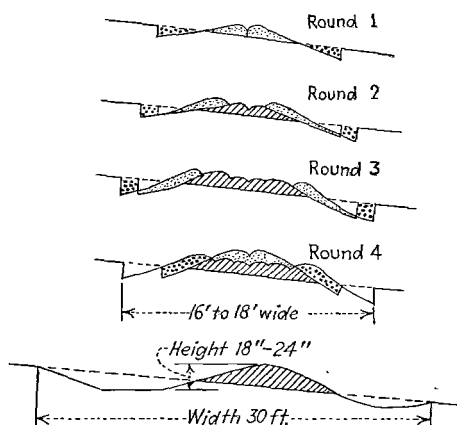


FIG. 693.—Terrace built with two-wheel terracer shown in Fig. 688. The terrace is built from both sides. After fourth round terrace is finished from upper side.

can be built in three or four rounds (Fig. 696) after which the channel is cleaned out and the terrace smoothed up in two or three rounds with a 12-foot blade grader.

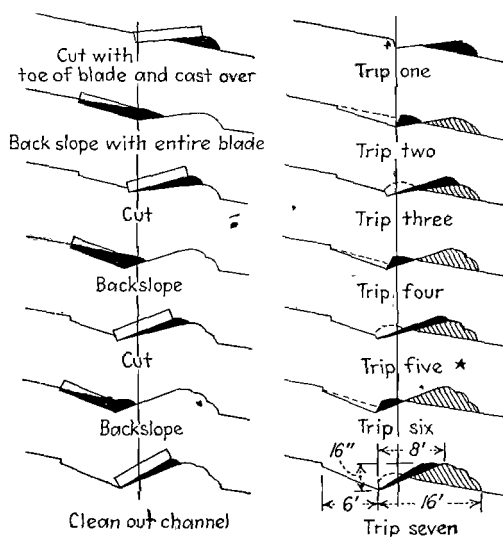


FIG. 694.—Terrace built from upper side.

The Missouri Experiment Station has developed a small power take-off elevating terracer that moves a good volume of earth (Fig. 697). In Missouri a 20-horsepower wheel-type tractor with the Wooley elevating terracer required 53 man-hours and 53 tractor-terracer-hours to

construct a mile of terrace containing 2,825 cubic yards per mile. In Iowa with a 22-horsepower tractor the outfit required 66 man-hours and 66 tractor-terracer-hours to construct a mile of terrace containing 2,863 yards per mile.¹

709. The Whirlwind Rotary Terracer.—This terracer consists of a shortened moldboard plow to cut and lift a furrow slice up into a rapidly revolving vertical power-driven auger, which throws the soil to the side² (Fig. 698). In operation the auger revolves about 1,060 revolutions per minute and the tractor travels about 5 miles per hour. In Iowa with a 22-horsepower wheel-type tractor, the whirlwind terracer required 50 man-hours and 50 tractor-terracer-hours to construct a mile of terrace containing 1,899 cubic yards per mile.¹

710. Cost of Constructing Terraces.—There are so many variables that enter into terracing costs that it is hard to arrive at a definite estimate. Numerous methods of calculating costs have been tried but the best seems to be based on the cost per foot, per 100 feet, or per mile of constructed terrace. Terraces in the Southeastern States average from 12 to 18 feet in width. In the Southwestern States terraces 20 to 24 feet wide and 18 inches high are recommended. In the high plains of the Middlewest they range from 40 to 50 feet in width. The Soil Conservation Service has adopted as a standard a width of 24 feet and a height of 18 inches with a 3-foot top width. Steep slopes require closer spacing of terraces than more gentle slopes. Hoover³ enumerates the factors that must be considered in calculating the cost of terracing as follows:

1. The field or area terraced, including lineal feet of terrace necessary, the slope in per cent, soil type (surface and subsoil), vegetative cover, number of gullies to be crossed, and weather.

¹ Soil Conservation Service, U. S. Dept. Agr., unpublished data.

² *Agr. Eng.*, Vol. 16, No. 1, p. 6, 1935.

³ *Agr. Eng.*, Vol. 17, No. 2, p. 51, 1936.

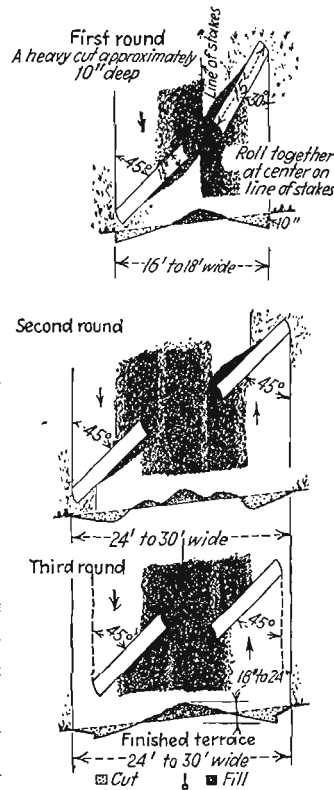


FIG. 695.—Showing angle of blade and cut for the first three rounds in constructing terrace with a road machine.



FIG. 696.—Large elevating grader building a terrace.



(Courtesy Mo. Agr. Expt. Sta.)

FIG. 697.—Light elevating grader.

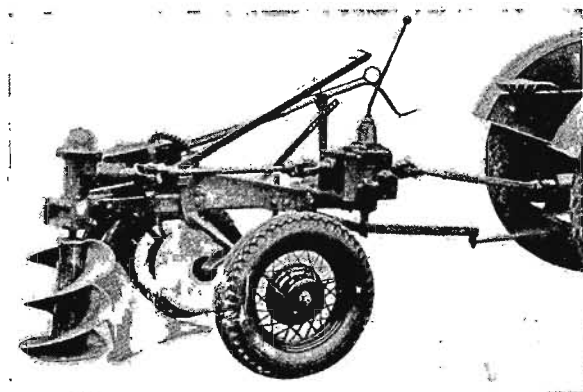


FIG. 698.—Whirlwind terracer.

2. The terrace built, including cross-section (height, width, and average distance dirt is moved laterally), and length.
3. The equipment, including size and make, condition, and skill of operators.
4. Cost of equipment and operating cost, including fuel consumption, grease used, depreciation, repairs and maintenance, interest on investment, and labor cost (operators).
5. Cost of engineering and supervision.
6. Cost of fresno or other work to bring low spots up to grade.
7. Outlet cost.

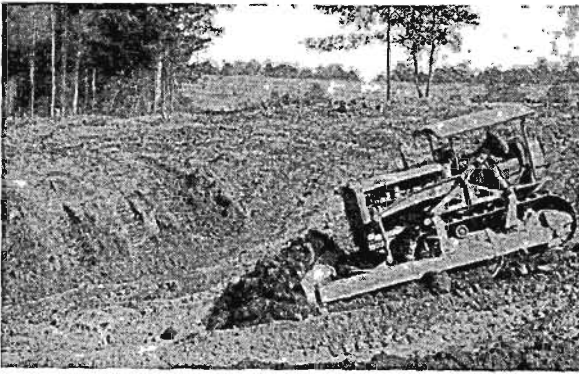


FIG. 699.—Bull-dozer filling gully.

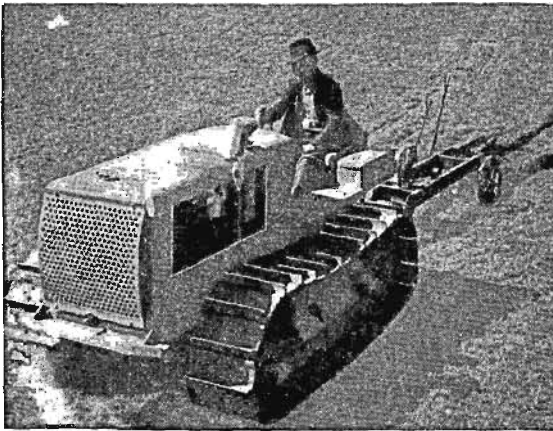


FIG. 700.—Special sod cutter and contouring plow.

When all of these factors are considered the cost arrived at is for the completed job and fully protected land. If all costs are not included, it would be like a man figuring the cost of laying the foundation as the total cost of his house. Unless the low spots and gullies are filled and outlets constructed, a terrace might as well not be built at all.

Ward¹ states that eight terracing associations in Virginia built terraces at an average cost of \$22.50 per mile.

Carter and Hulburt² state that the Rural Rehabilitation Corporation constructed terraces in Arkansas at \$17.85 per mile. These costs do not include outlet construction or fills.

Baird³ estimates the cost of building terraces in East Texas at \$30.00 per mile, or more.

Data presented by Ayres⁴ show the cost of constructing a terrace in Iowa was \$30.97 per mile when a 15-27 tractor and grader were used and \$32.65 when a general-purpose tractor and three-wheel farm grader were used. He also gives data on the cost of constructing terraces with several other types of machines.

TABLE XXVII.—COST OF CONSTRUCTING 124 MILES OF TERRACE IN THE VICINITY OF SAN ANGELO, TEXAS

Miles of terrace built	Labor	Transportation	Fuel	Depreciation	Total cost	Cost per mile	Total number hours running	Number of hours per mile
124	\$1511.26	\$211.12	\$528.78	\$1254.21	\$3505.67	\$28.27	2110	17.01

NOTE: Labor charge 0.335 cent per hour.

Depreciation on tractor 0.471 cent per hour.

Depreciation on grader 0.121 cent per hour.

Transportation of crew to and from work charged at the rate of 0.02 cent per hour.

¹ *Extension Service Rev.*, Vol. 7, No. 7, p. 105, 1936.

² *Agr. Eng.*, Vol. 17, No. 12, p. 511, 1936.

³ *Agr. Eng.*, Vol. 16, No. 1, p. 5, 1935.

⁴ *Soil Erosion and Its Control*, McGraw-Hill Book Company, Inc., p. 168, 1936.

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